PERFORMANCE MEASURES FOR TRAFFIC SIGNAL MAINTENANCE

Jay Grossman, Elkhart County Highway Department

Ver. 2

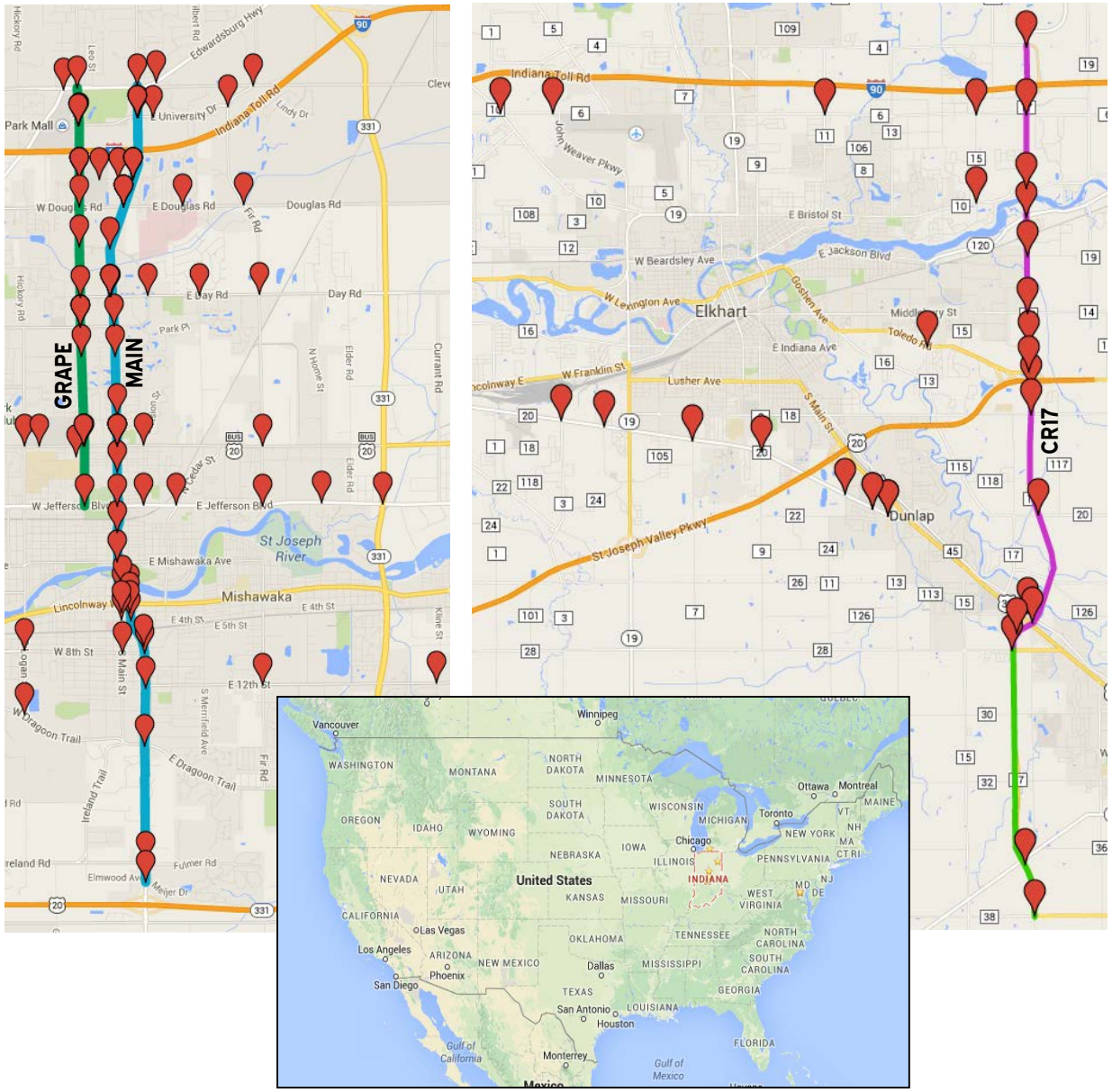
Outline:

- **Background and Motivation**
- Pedestrian Calls
  - Operational Verification
  - Methodology
  - Call Button Error Detection
- Vehicle Detector Analysis
  - Methodology
  - Case Studies
  - Conclusions

Maintenance Performance Measures
Developed on two local agency systems in Indiana

Mishawaka

64 signals
37 reporting
22 with peds
1181 detection channels
6.6 M records per day



Elkhart County

29 signals
21 reporting
3 with peds
671 detection channels
2.7 M records per day

Original Performance Measure Evolution

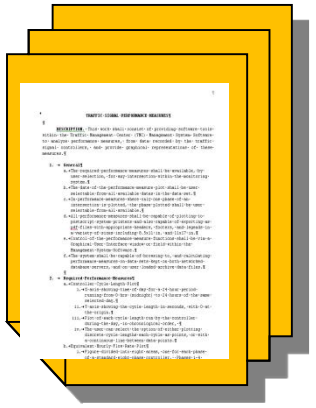
2003

2006

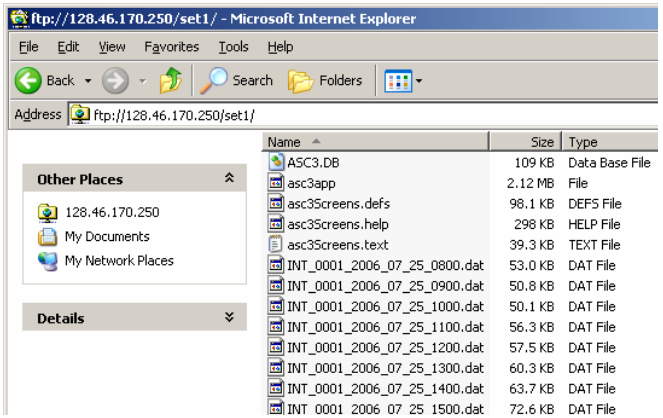
Central System

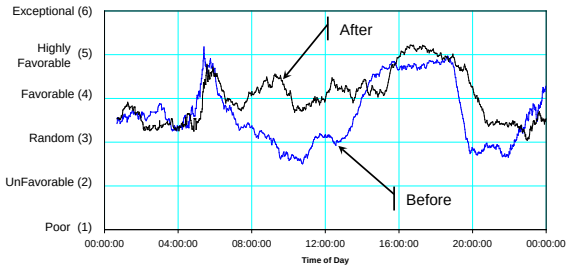
2011

Procurement Specification



2010

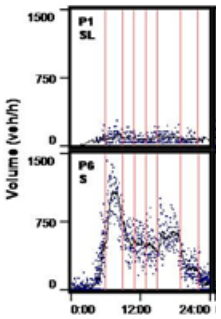




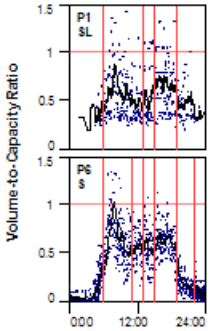
2008

Performance Measures Converted to Specifications

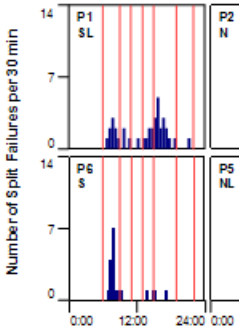
Equivalent Hourly Flow Rate



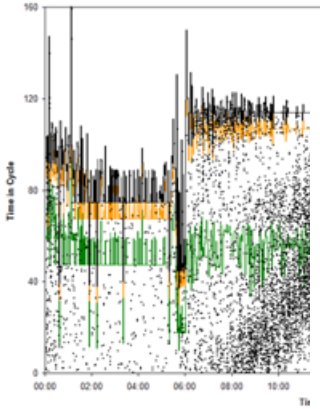
Volume to Capacity Ratio



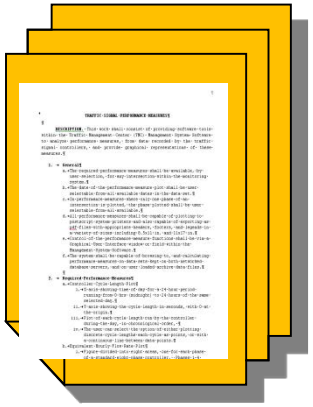
Split Failures Per Half Hour



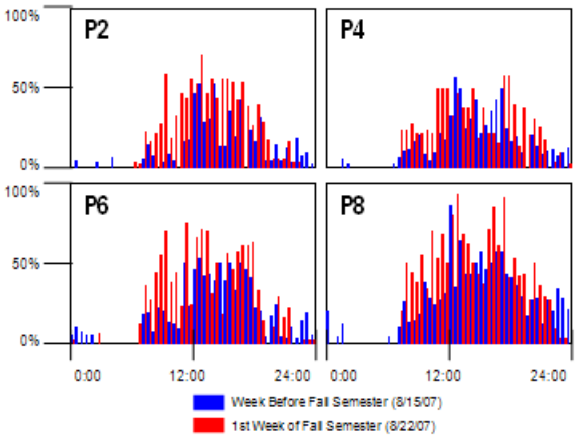
Purdue Coordination Diagram (PCD)



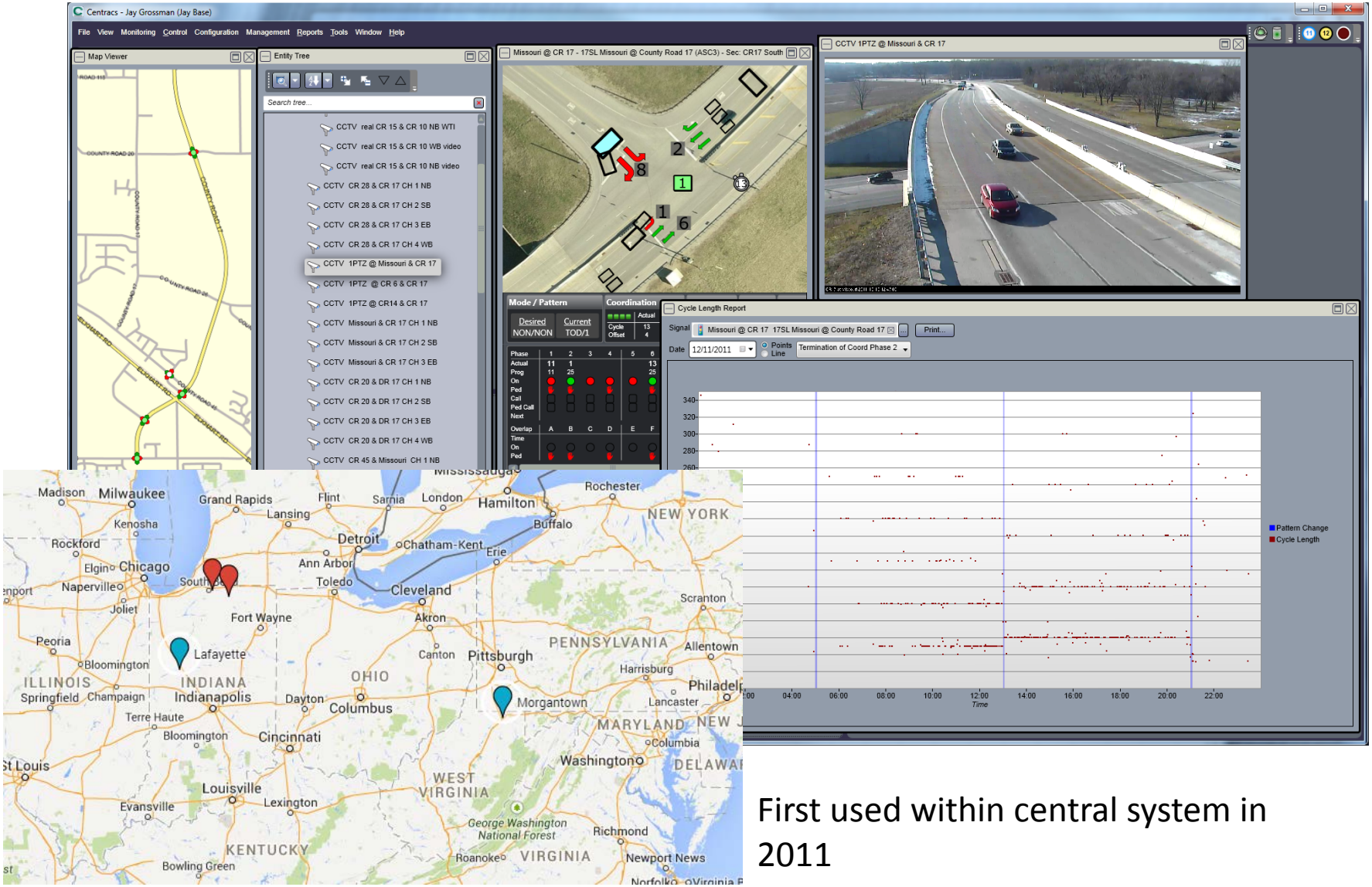
Procurement Specification



Percentage of Phases with Peds



Reports generated within central system



First used within central system in 2011

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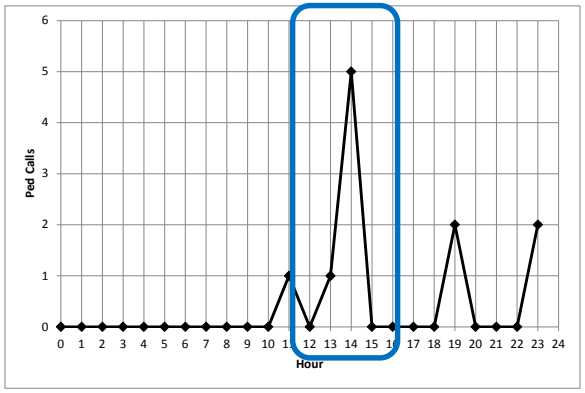
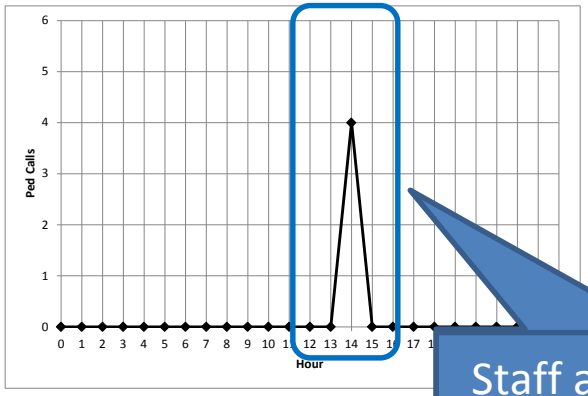
Pedestrian Calls
Operational Verification

Some phases are rarely activated. Still working?

ϕ2

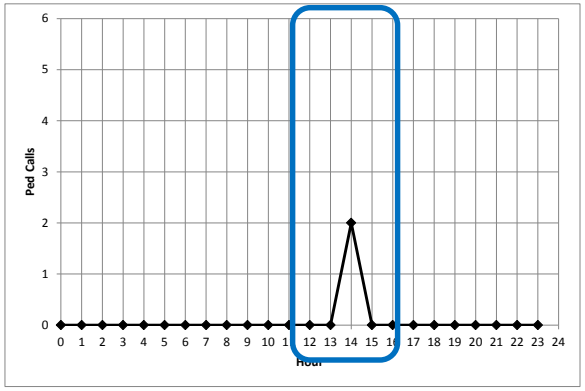


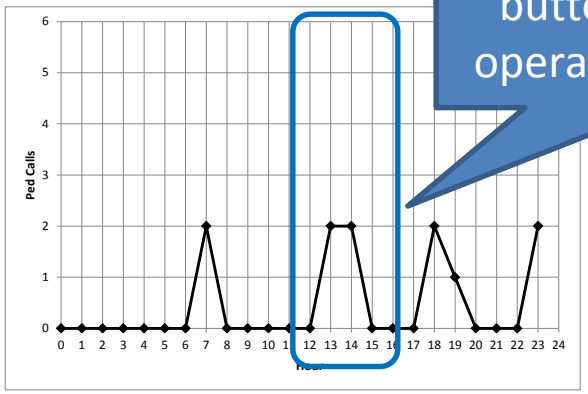
ϕ4



Staff activated each call button, logs used for operational verification

Activations





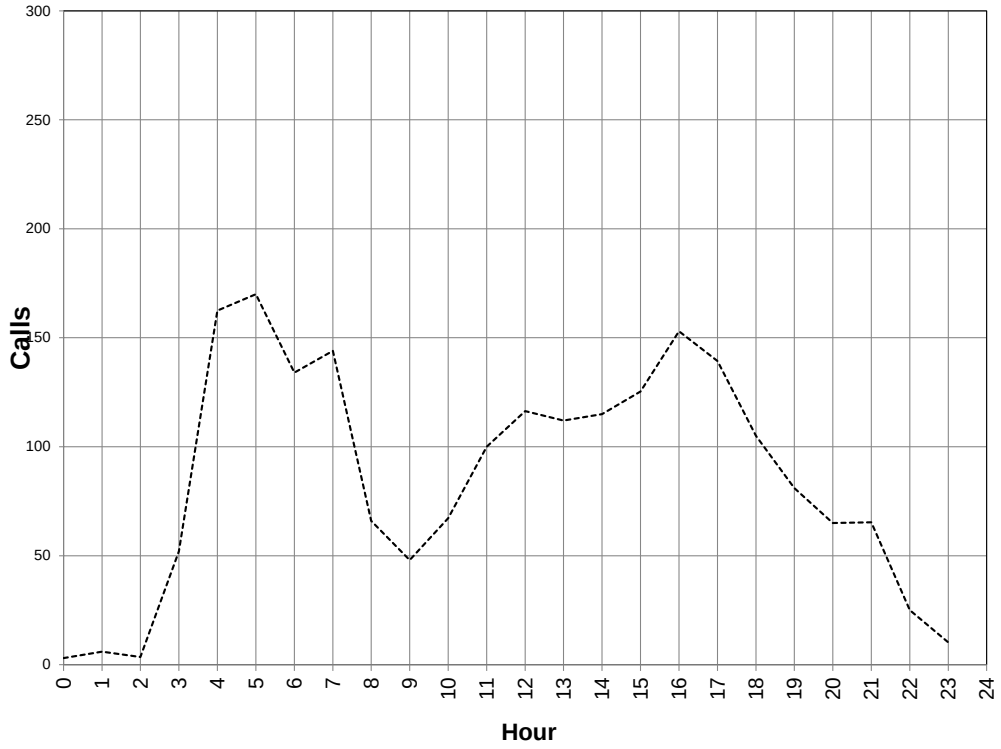
Hour of Day

ϕ6

ϕ8

Methodology:

- **Use Historic Data for a sensor channel to develop base lines of 'normal' behavior**
- Plot current period activity
- Identify potential errors



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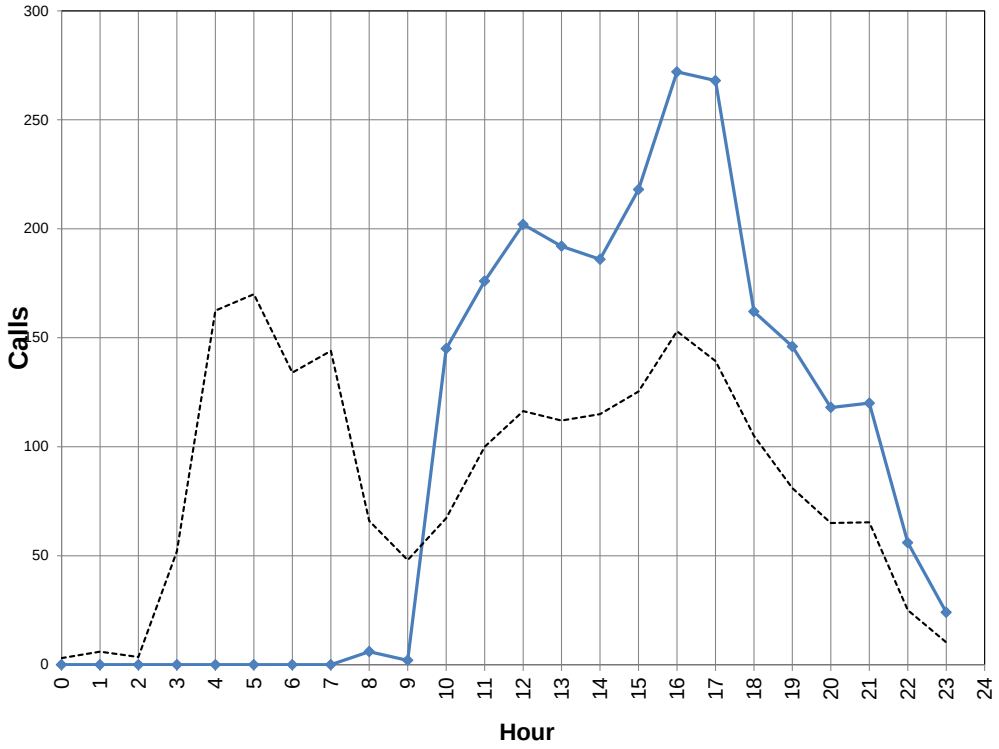

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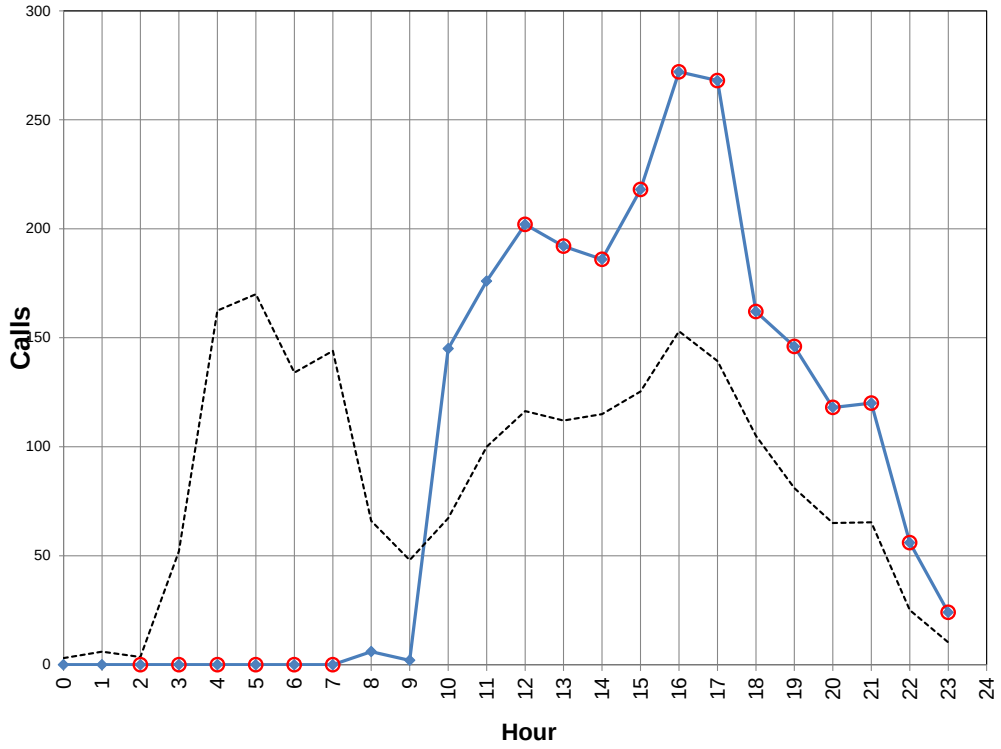
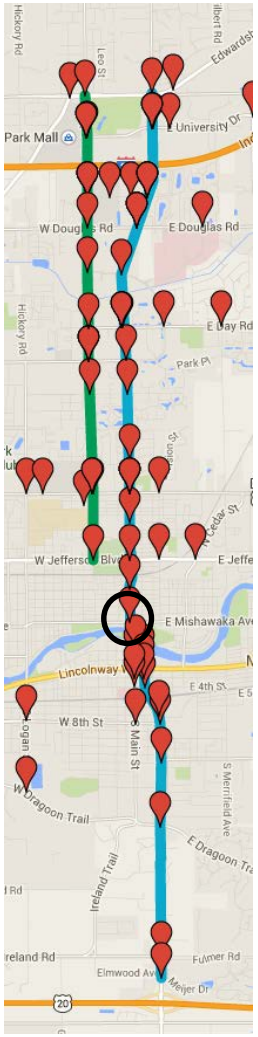
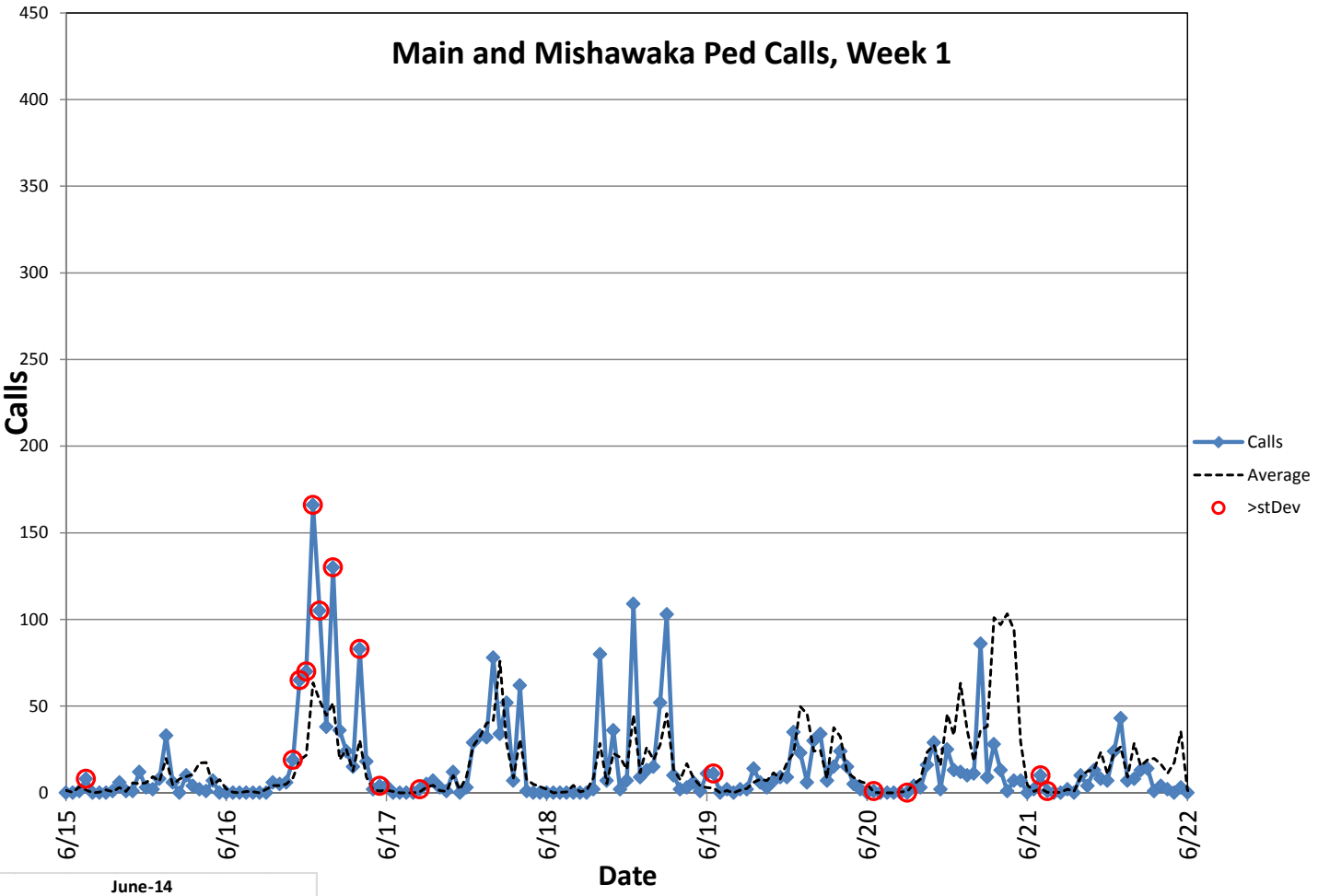


Mishawaka: pedestrian call analysis





June-14						
S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
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29	30					

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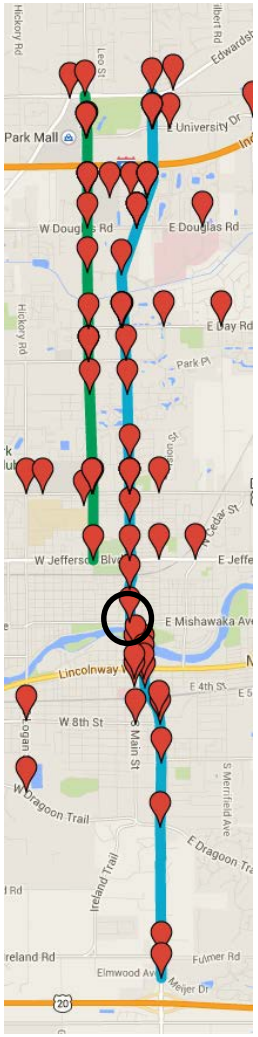

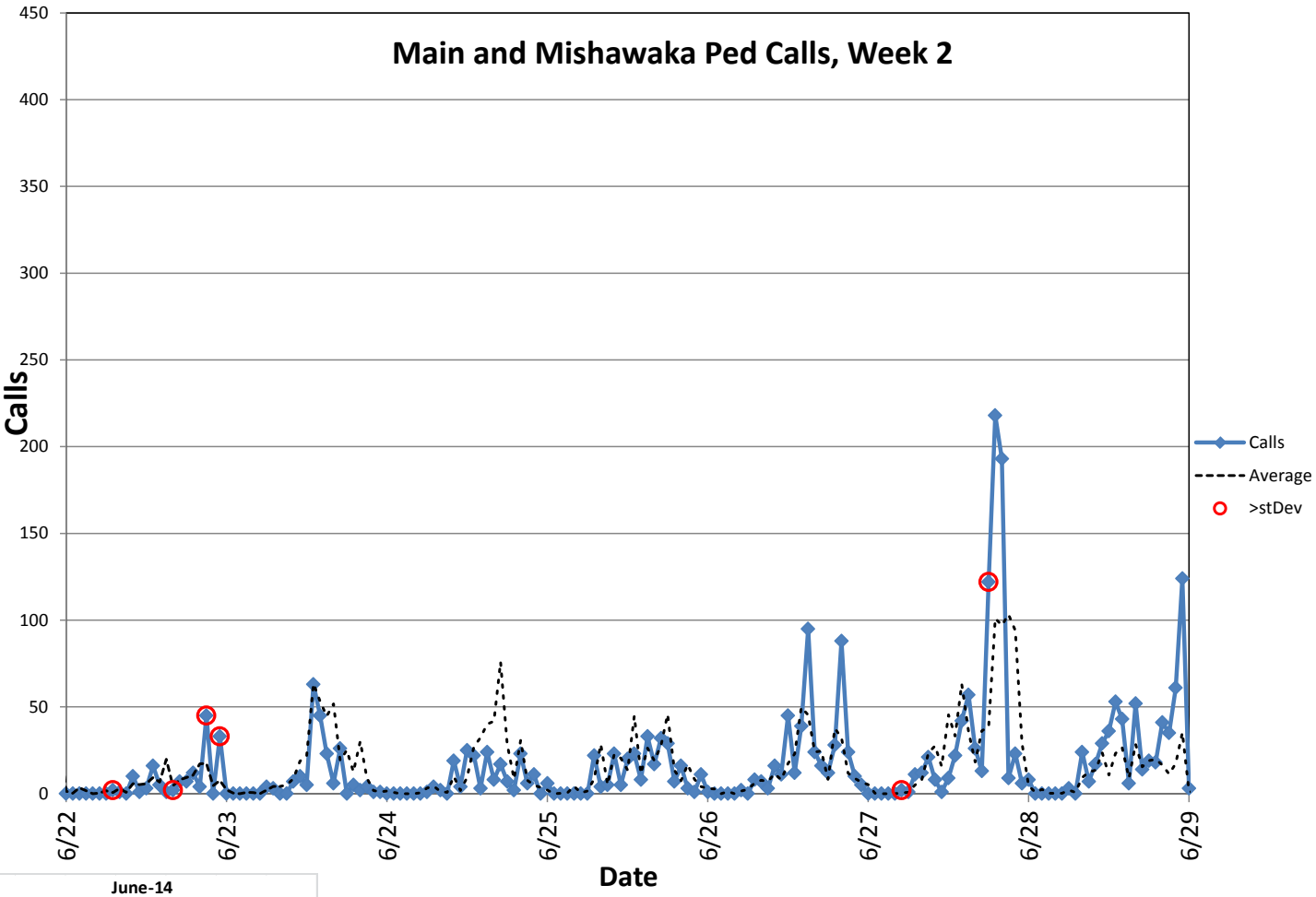

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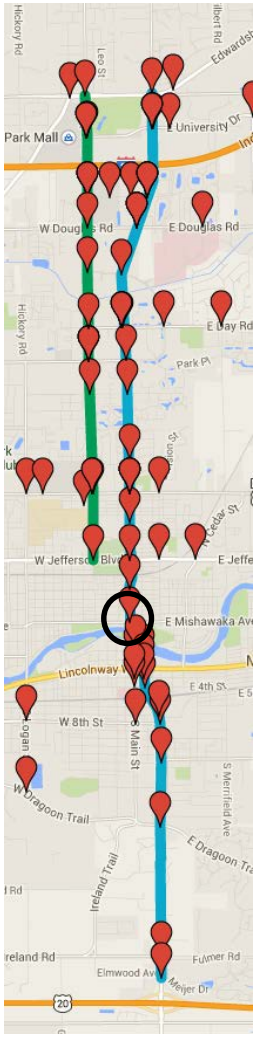

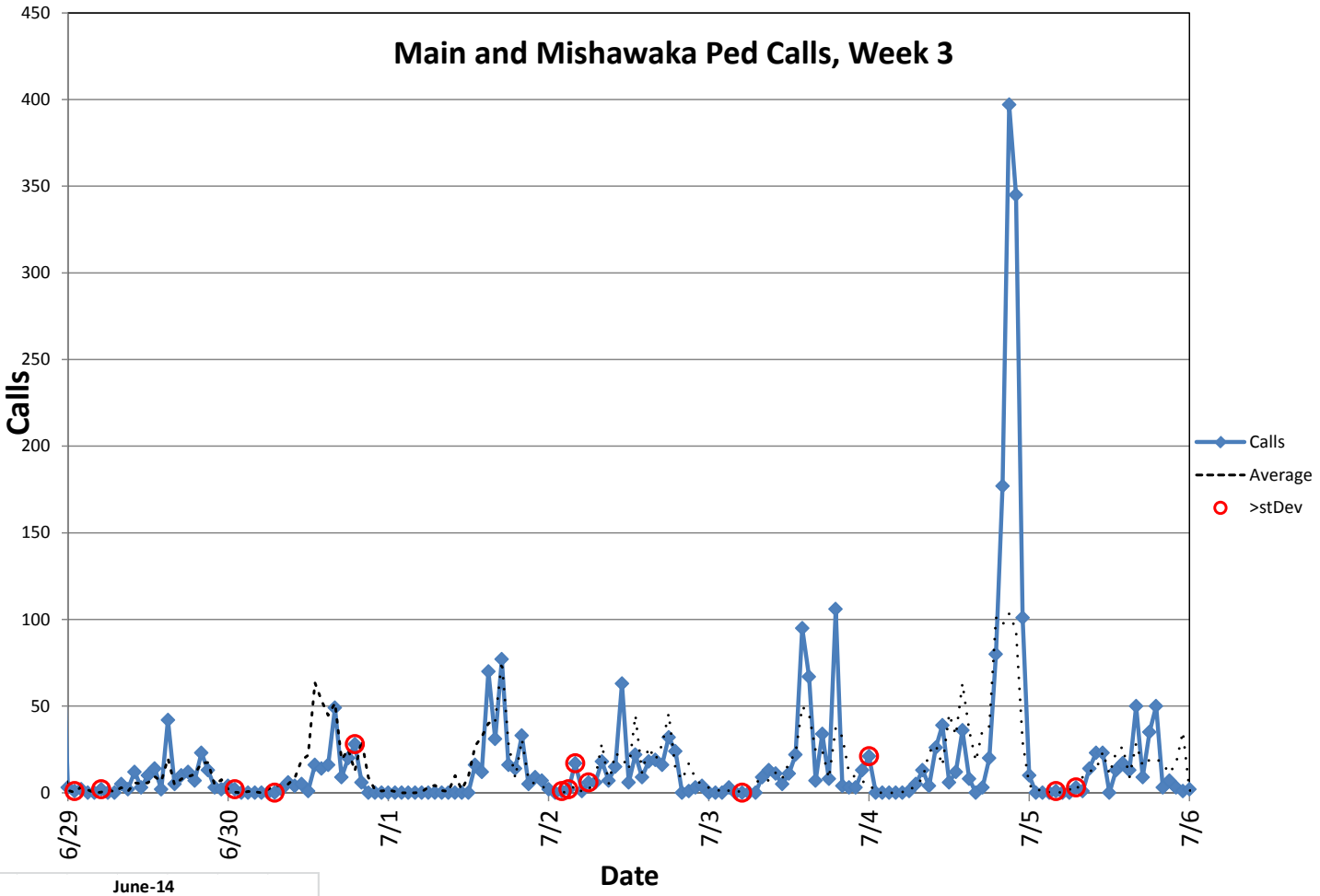

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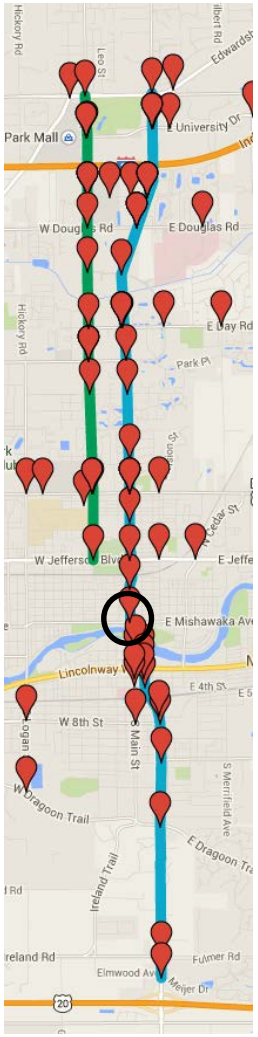

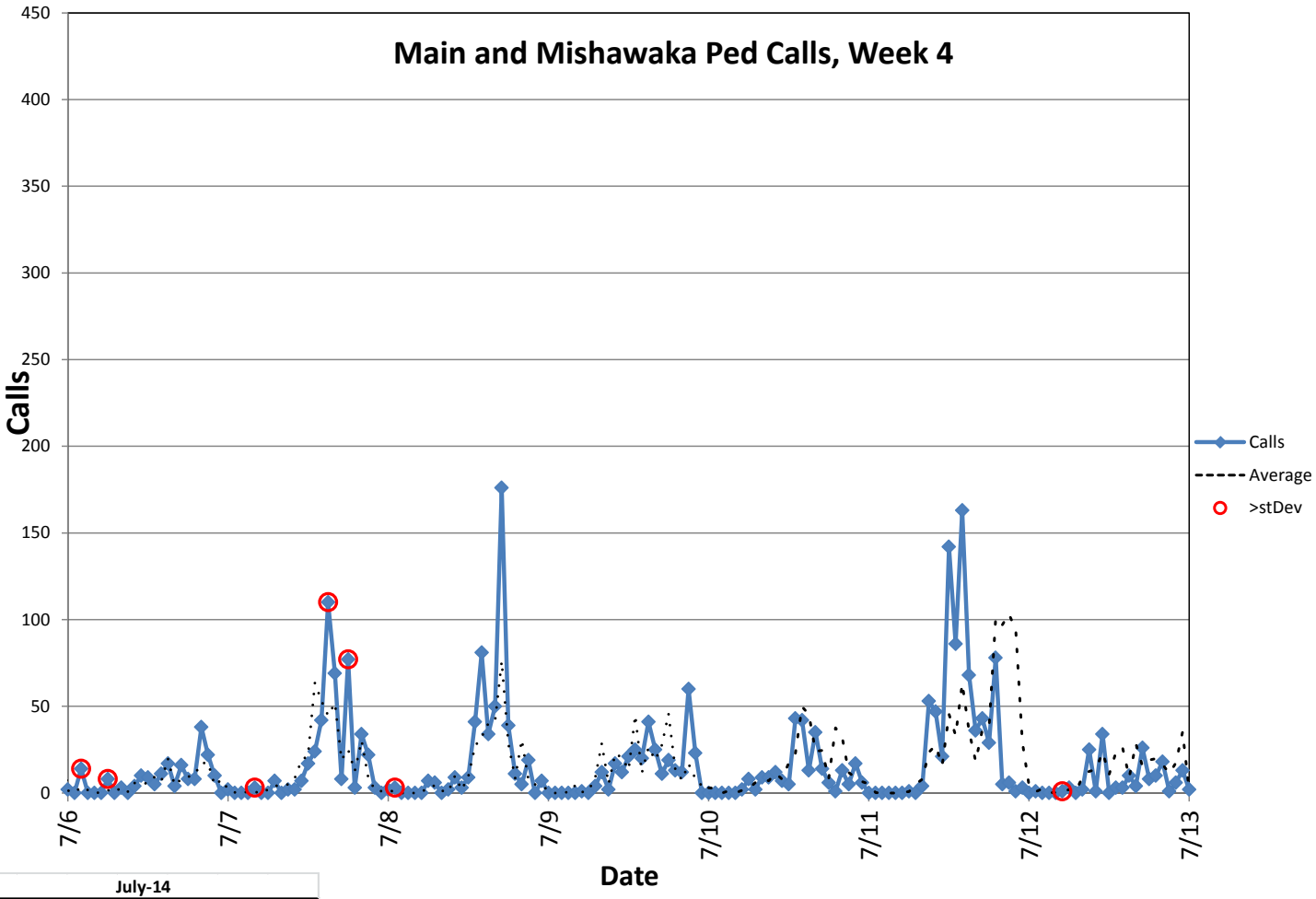

July-14						
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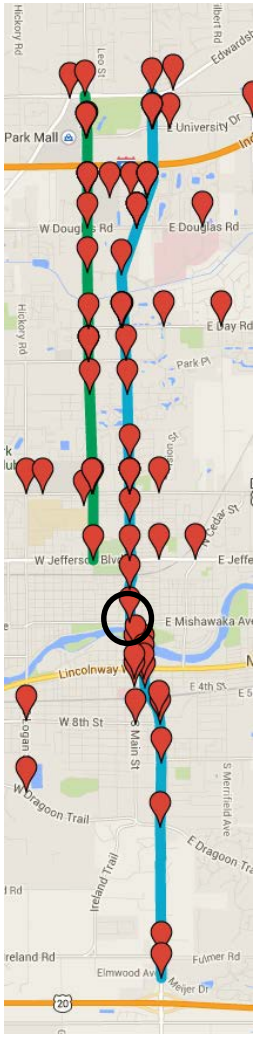
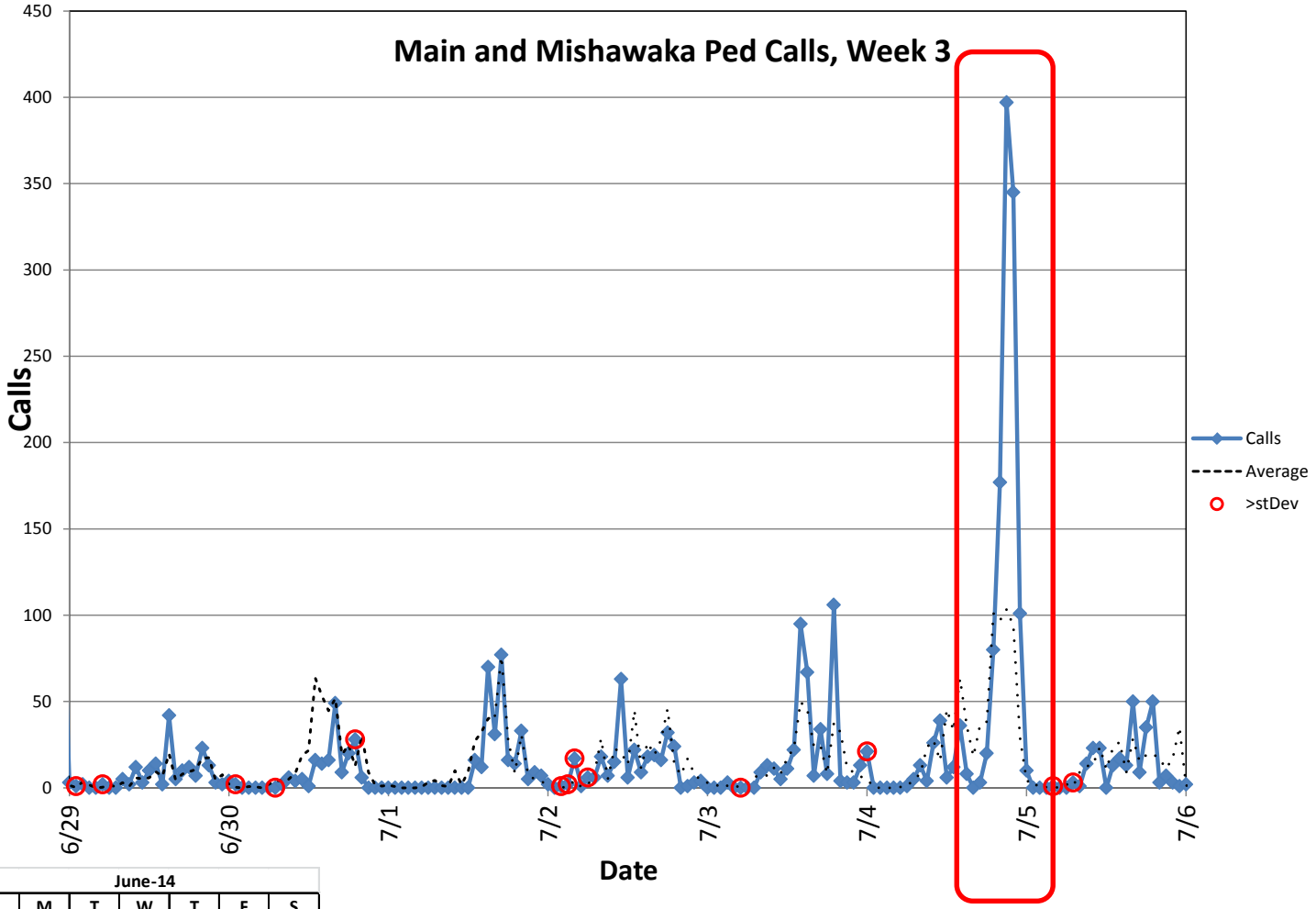
Mishawaka: pedestrian call analysis





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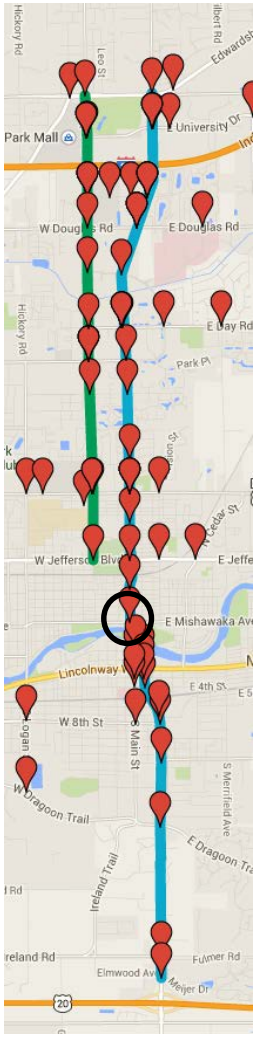

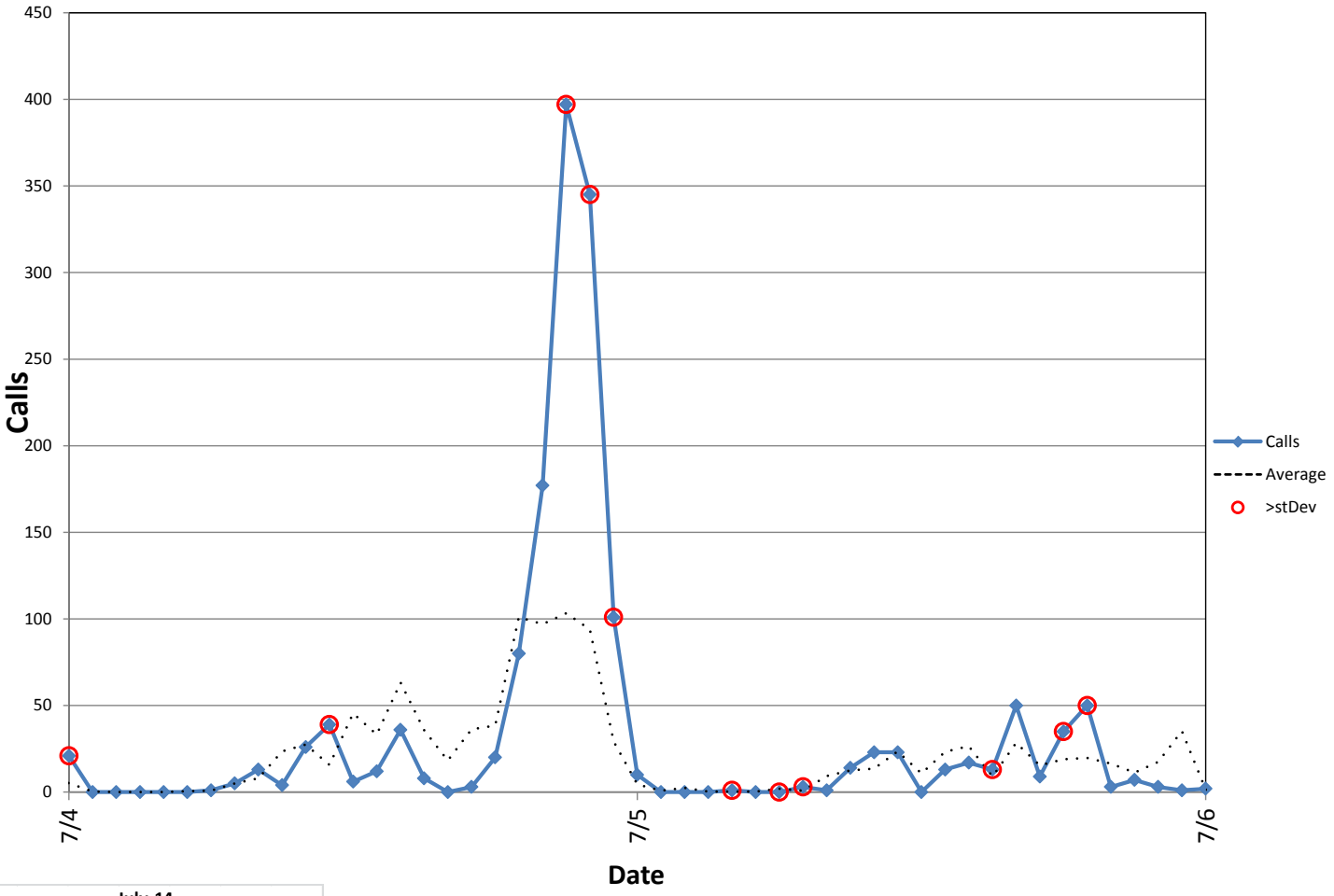

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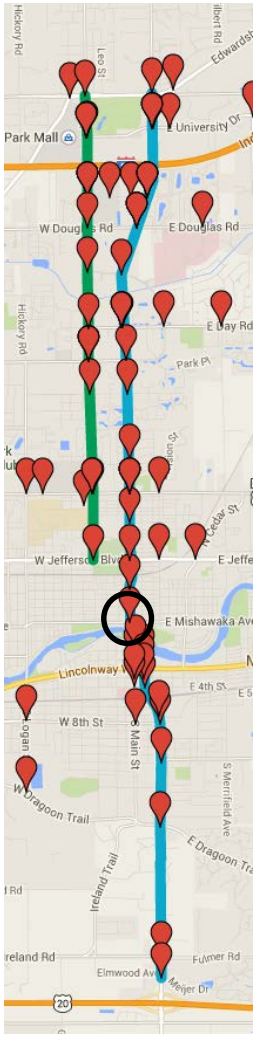

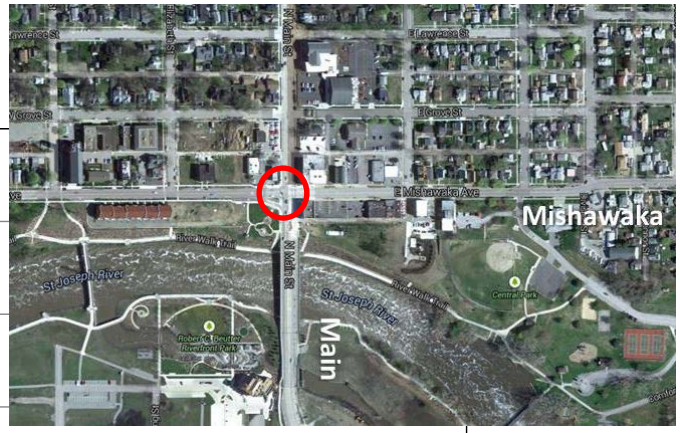

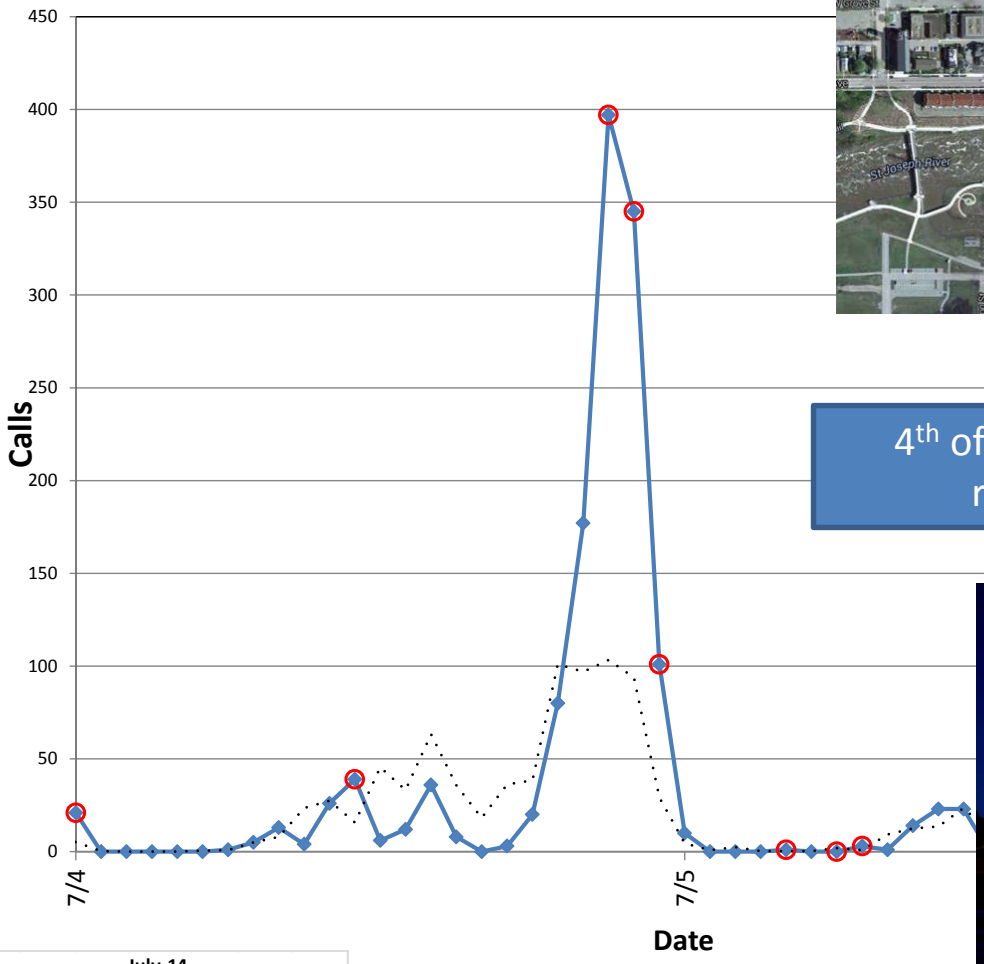

4th of July, adjacent to a park on riverfront, not an error

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- **Vehicle Detector Analysis**
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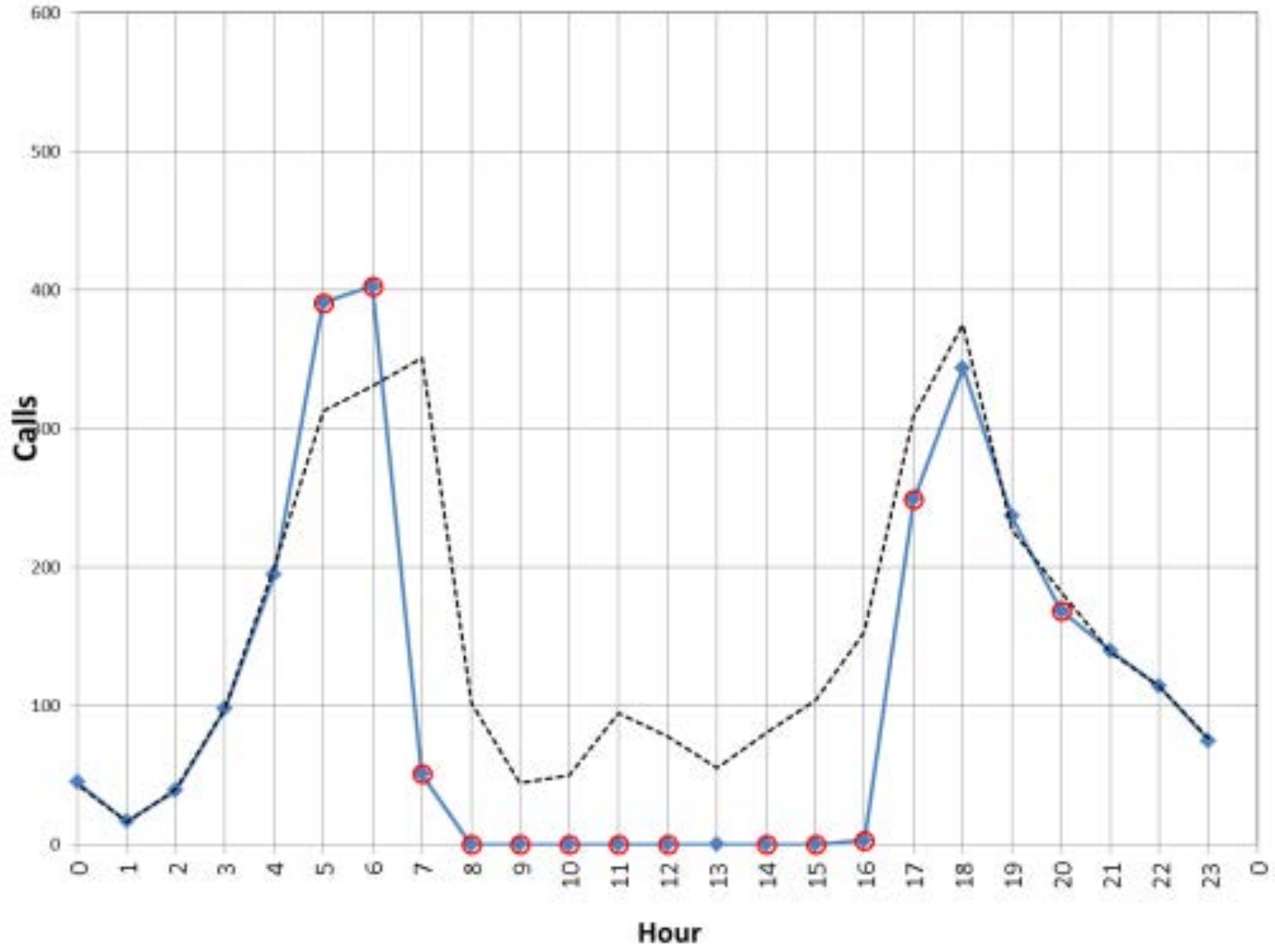
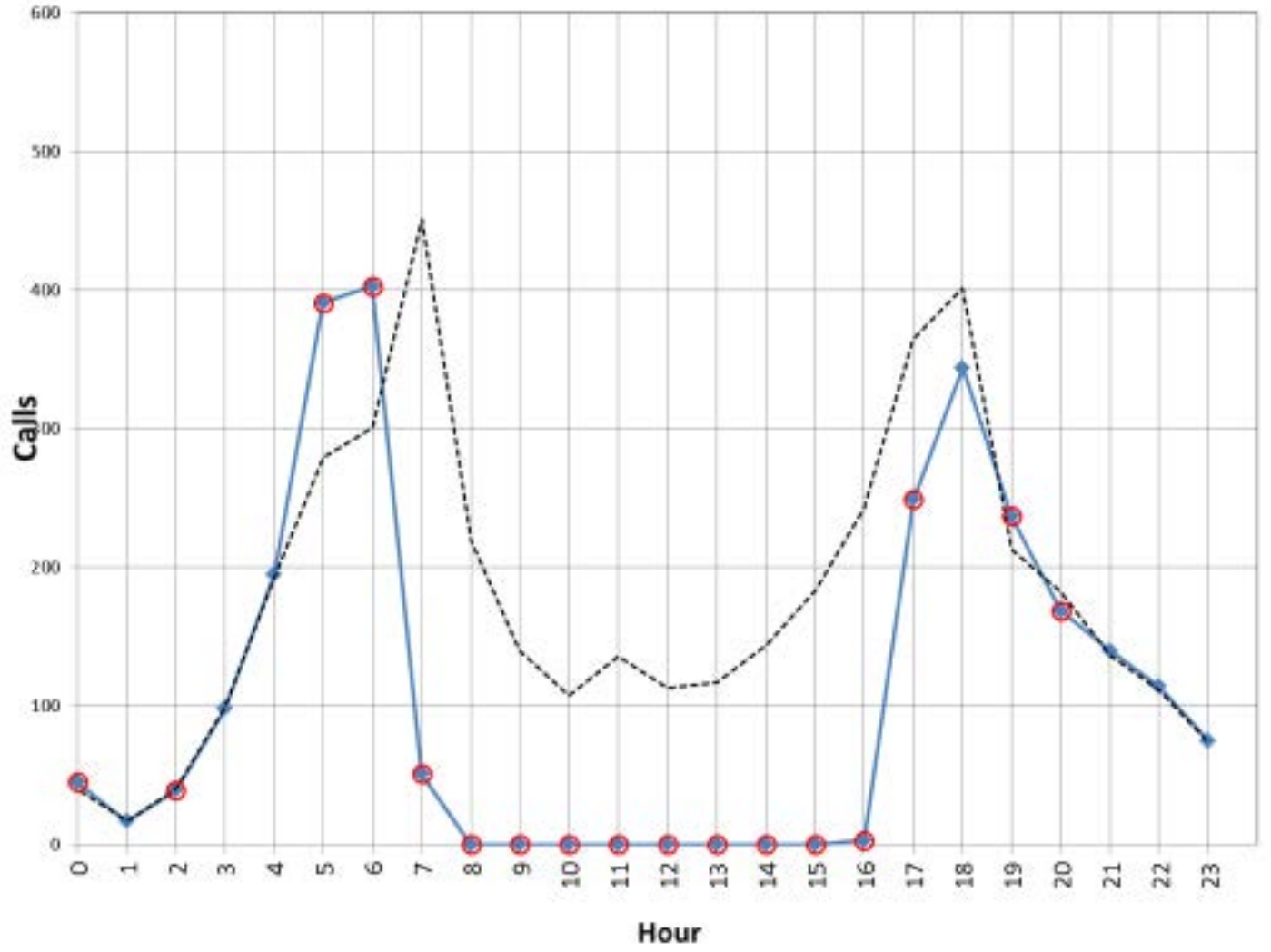
Vehicle Detector Analysis
Methodology: Base Line

1 Week of Data



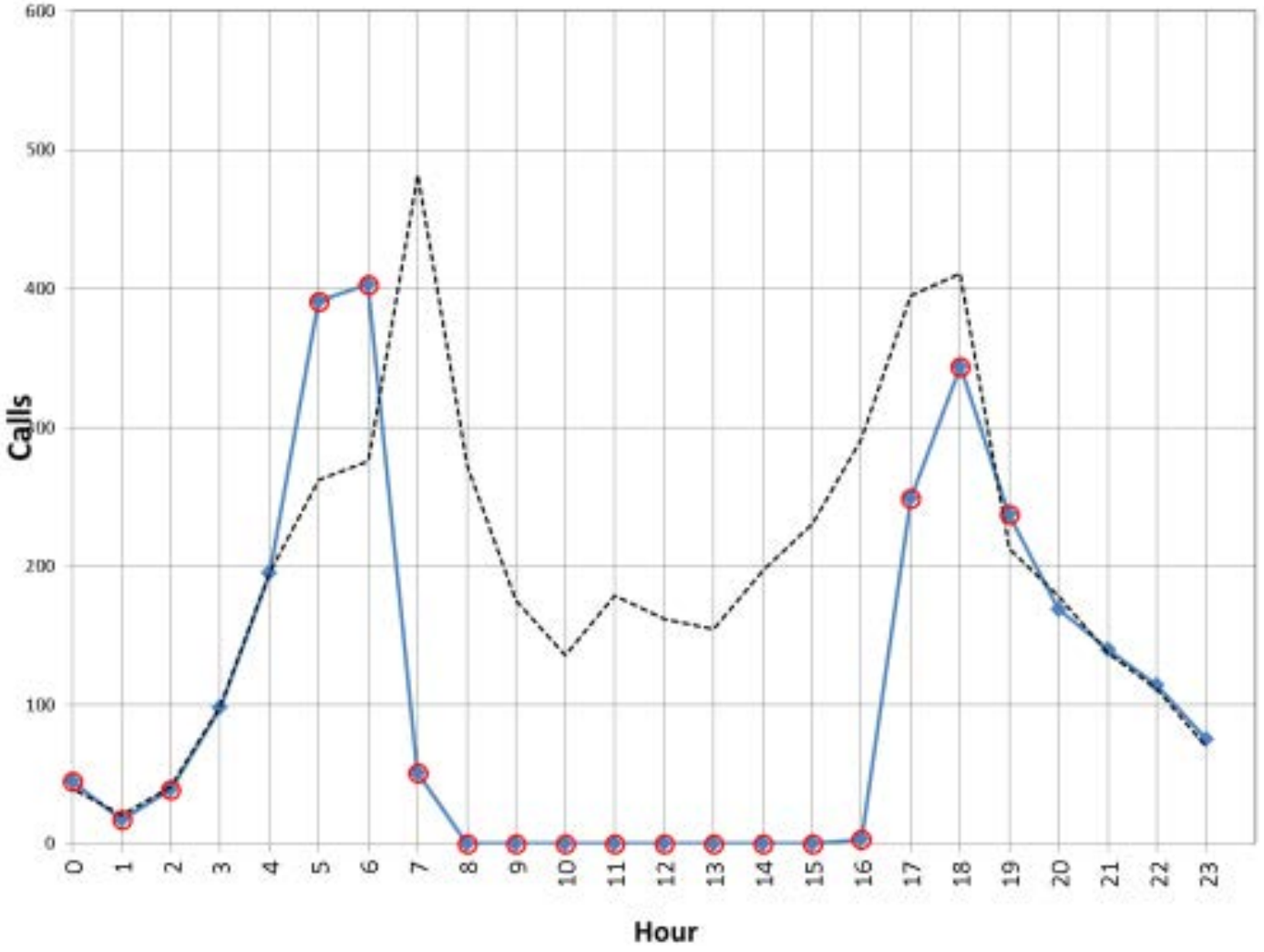
Vehicle Detector Analysis
Methodology: Base Line

2 Weeks of Data



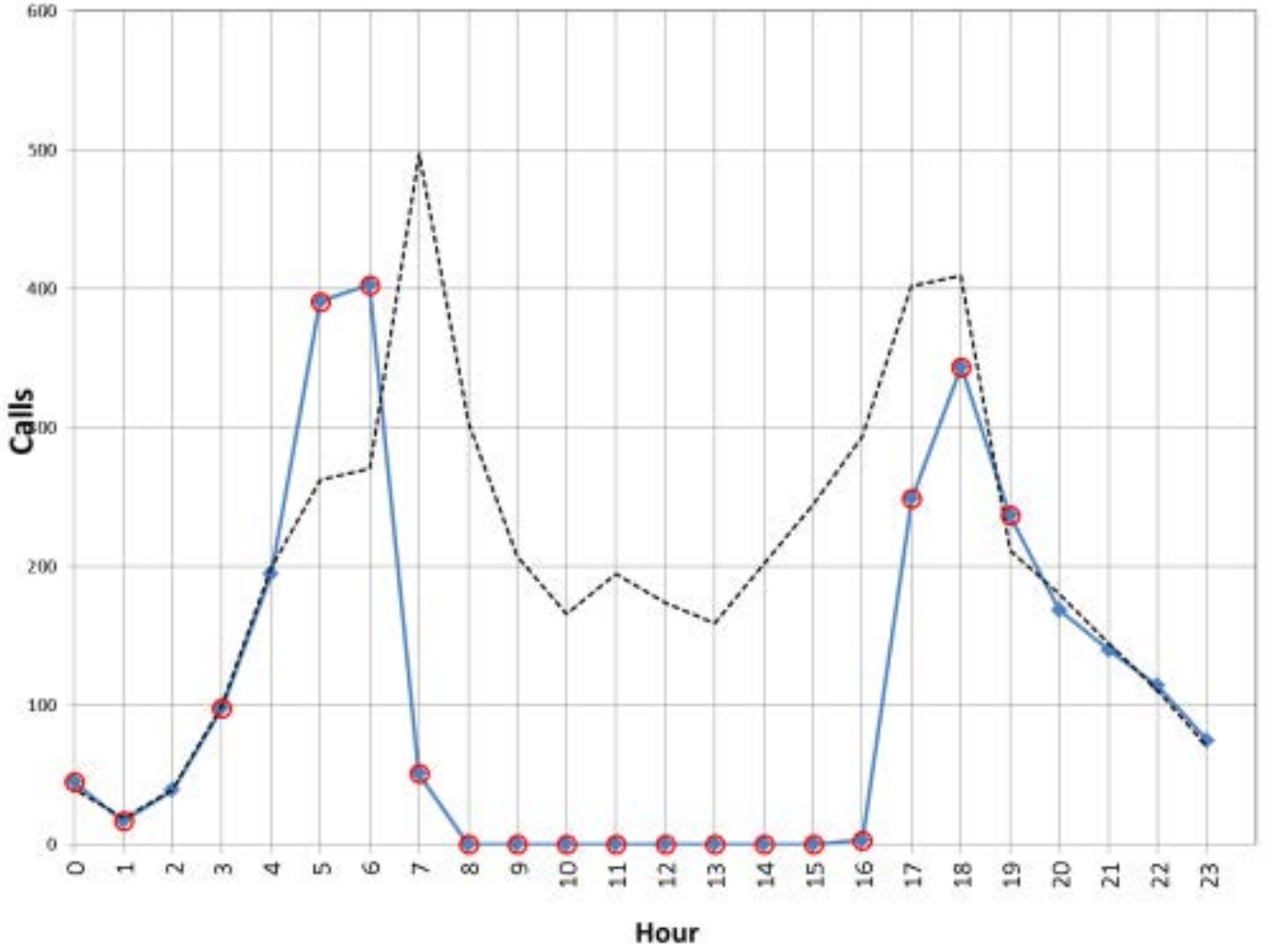
Vehicle Detector Analysis
Methodology: Base Line

3 Weeks of Data

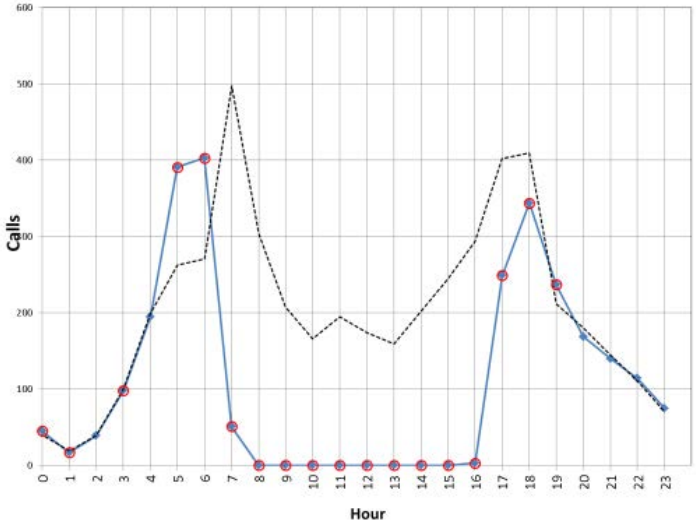


Vehicle Detector Analysis
Methodology: Base Line

4 Weeks of Data

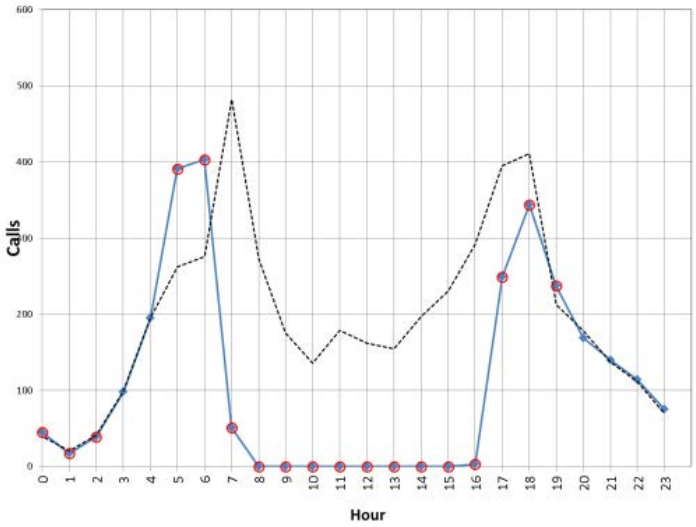


Vehicle Detector Analysis Methodology: Base Line



3 Weeks of Data

Three weeks of data for base line creation has worked best in our analysis. Four weeks adds little extra detail for error identification



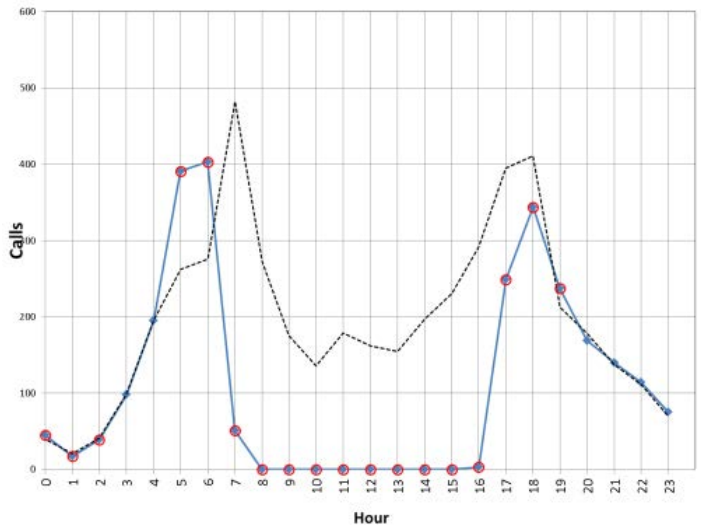
4 Weeks of Data

Computationally, entire system of more than 1100 detection channels can be analyzed in less than 5 minutes

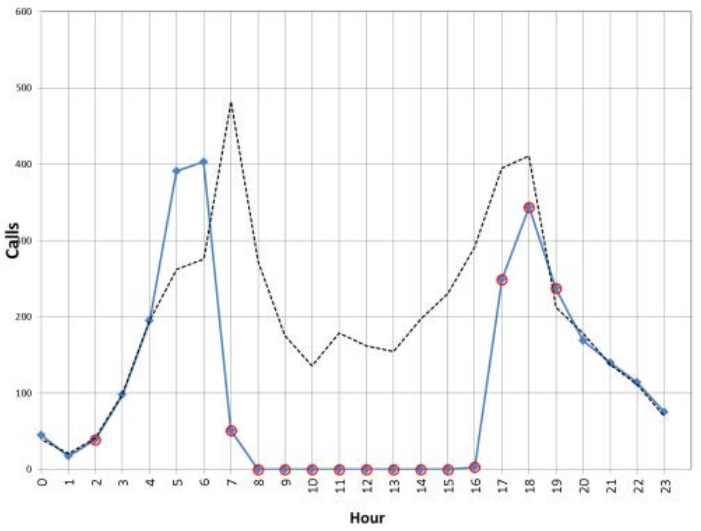
Vehicle Detector Analysis
Methodology: Error Threshold

Minimize false error alerts

Standard Deviation >= 1.5

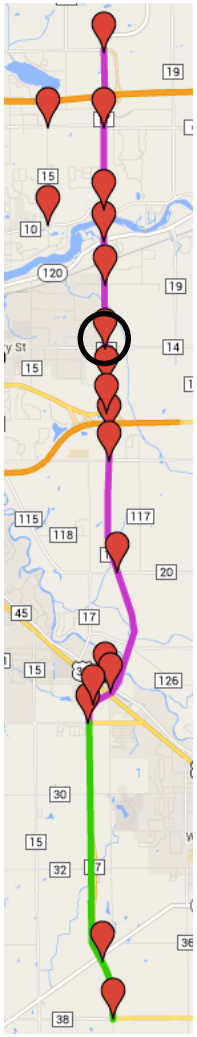


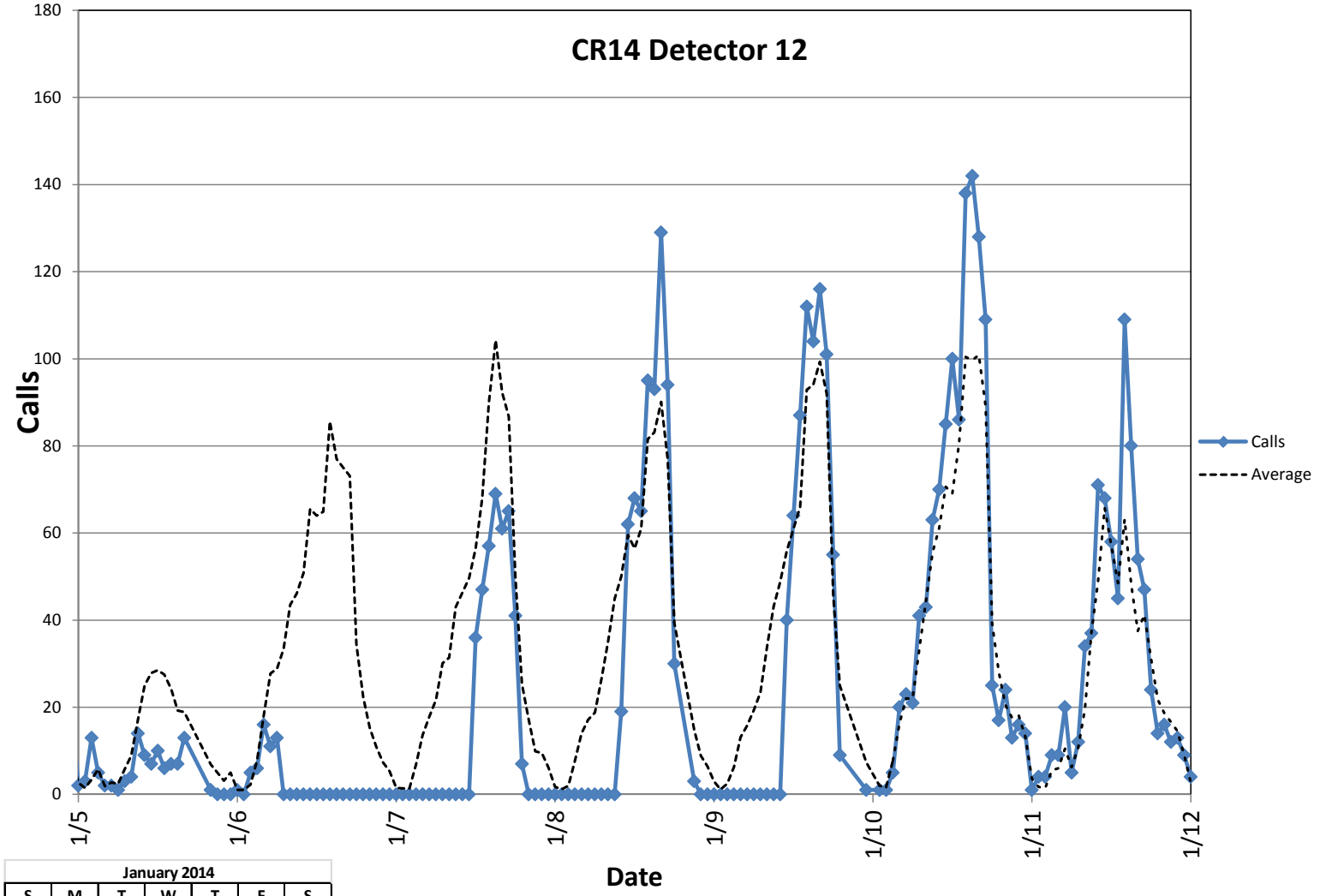
Standard Deviation >= 1.5
3 Consecutive Errors



Standard deviation threshold better as a user definable value due to range of normal calls for various detectors within system. 1.5—2.0 is generally a good range.

Case Study: CR 14 January error event





January 2014						
S	M	T	W	T	F	S
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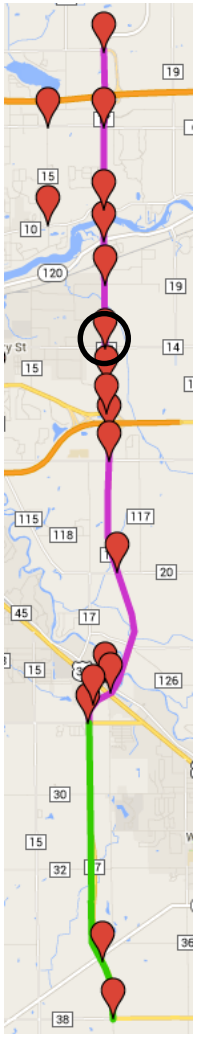

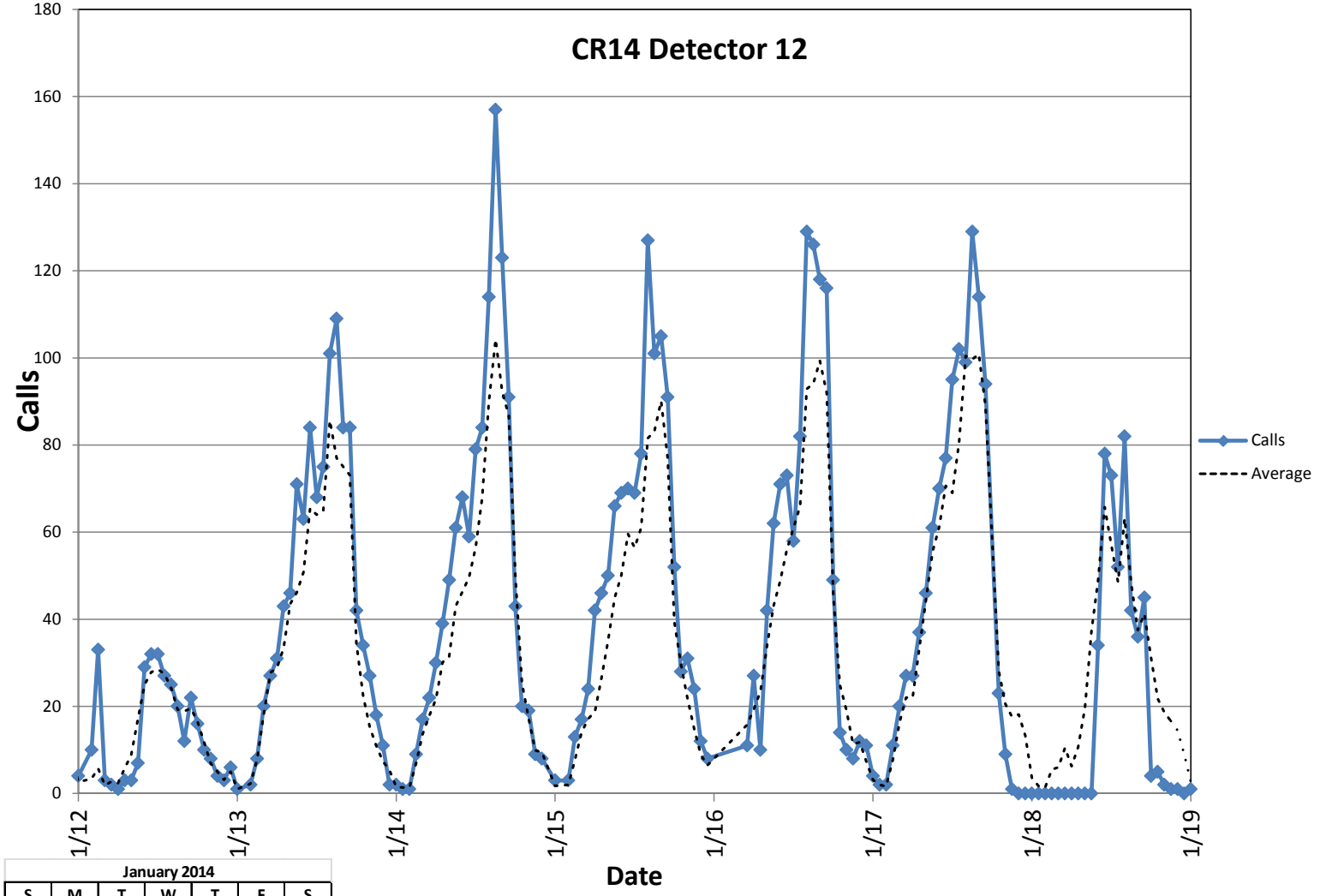

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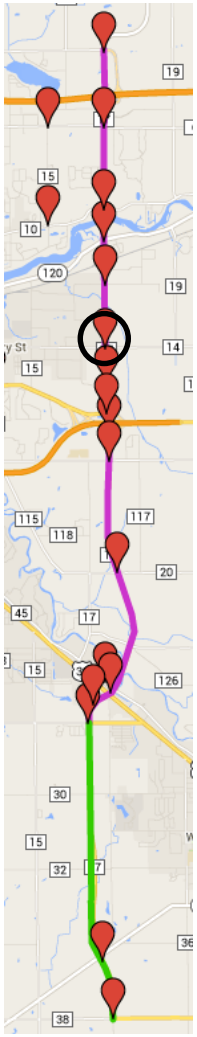
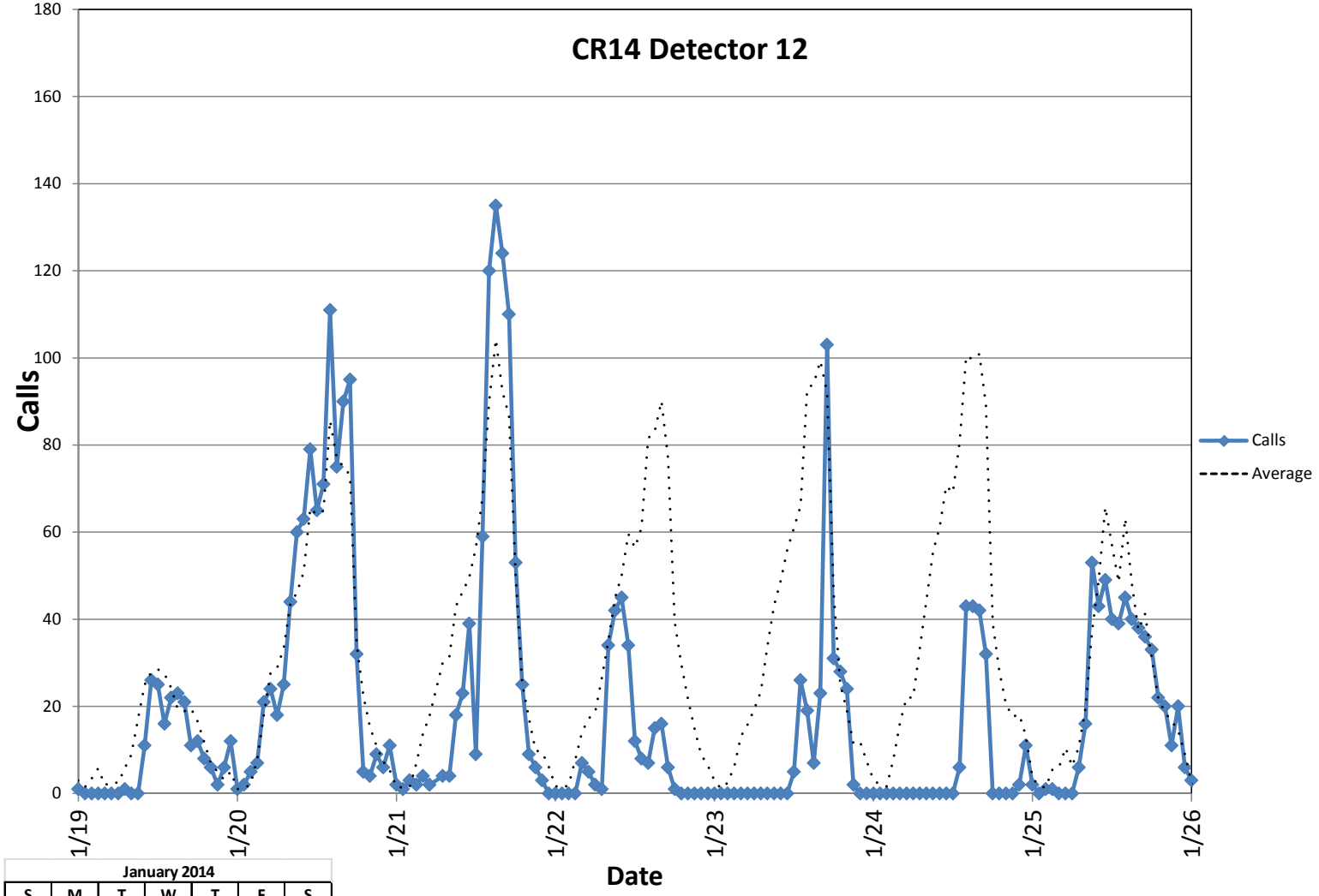
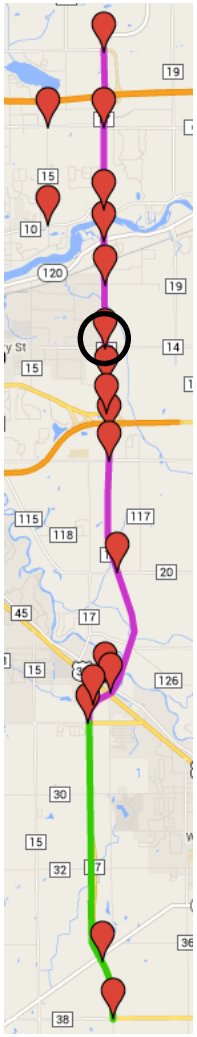
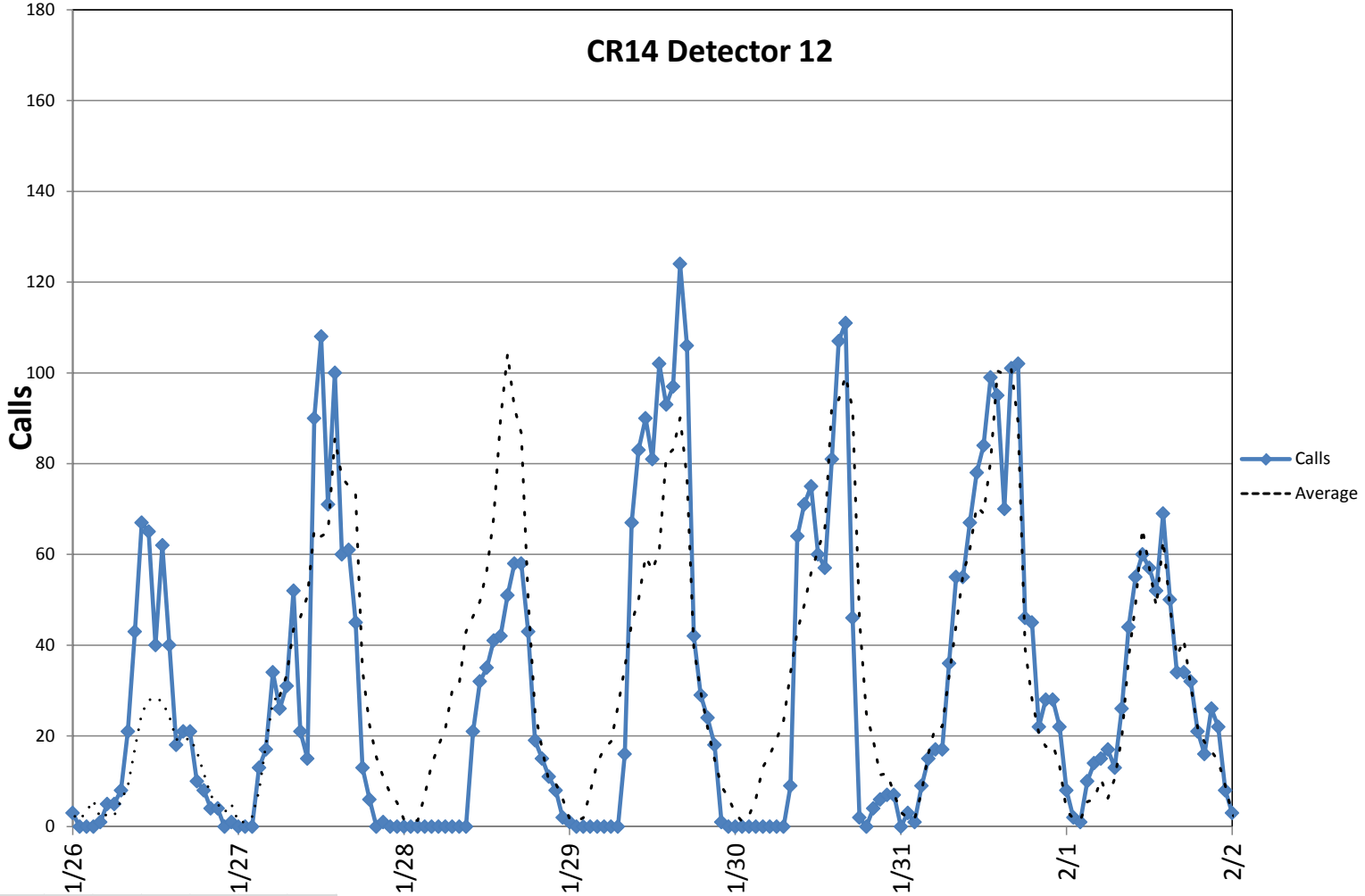




January 2014						
S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

Case Study: CR 14 January error event





January 2014						
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5	6	7	8	9	10	11
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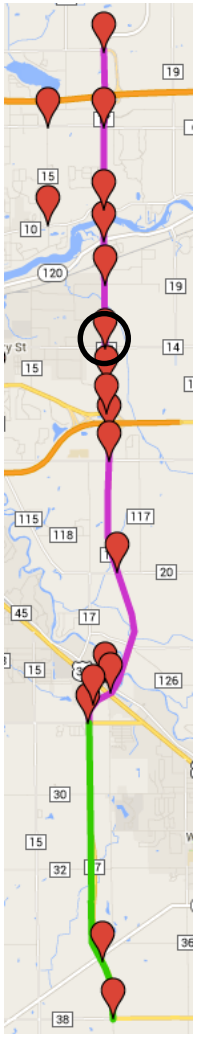
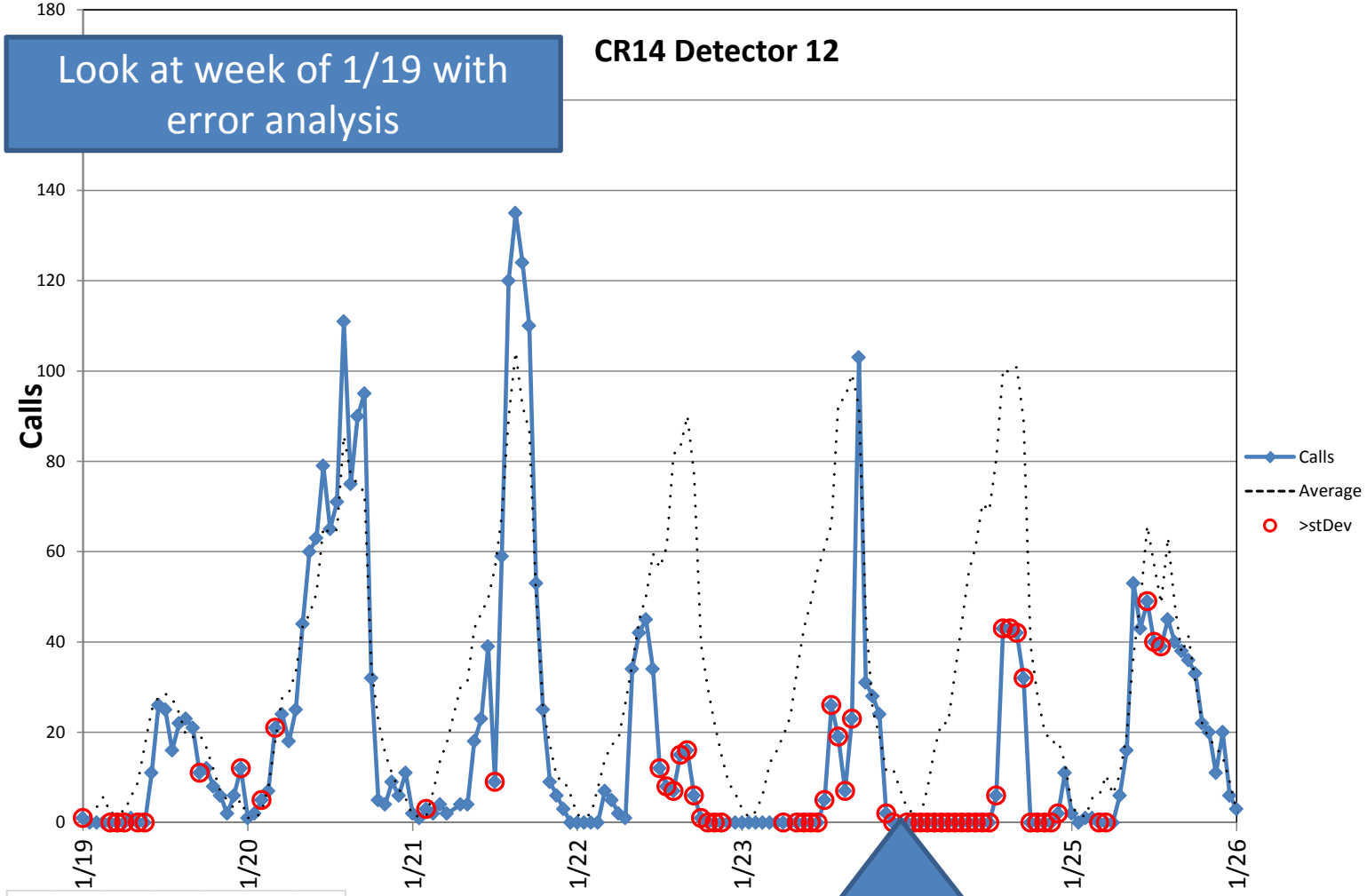
Case Study: CR 14 January error event



Look at week of 1/19 with error analysis



January 2014						
S	M	T	W	T	F	S
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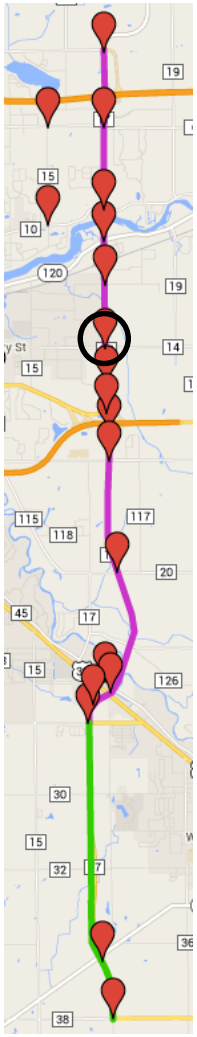
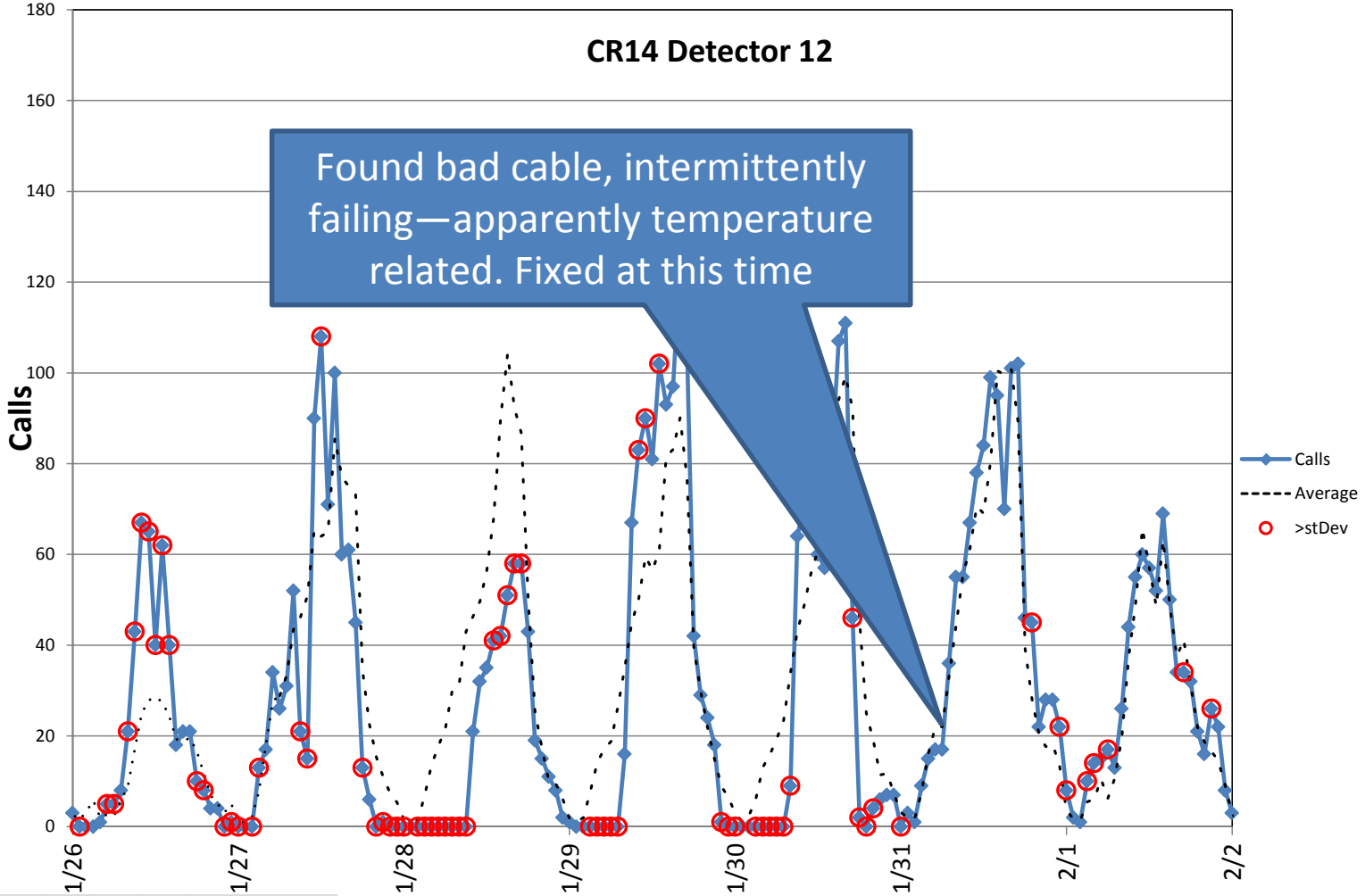
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

Unusual pattern of intermittent errors, generally early morning

Case Study: CR 14 January error event





January 2014						
S	M	T	W	T	F	S
			1	2	3	4
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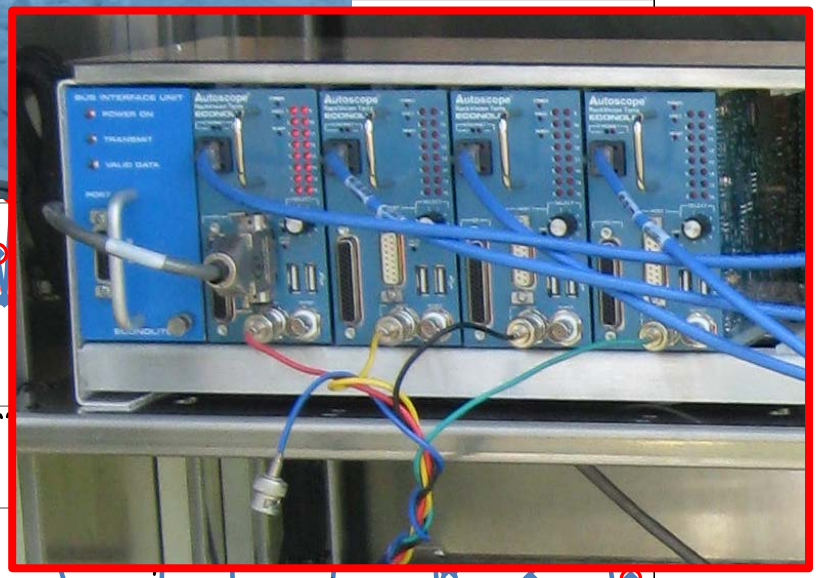
Autoscope
Autoscope
Autoscope
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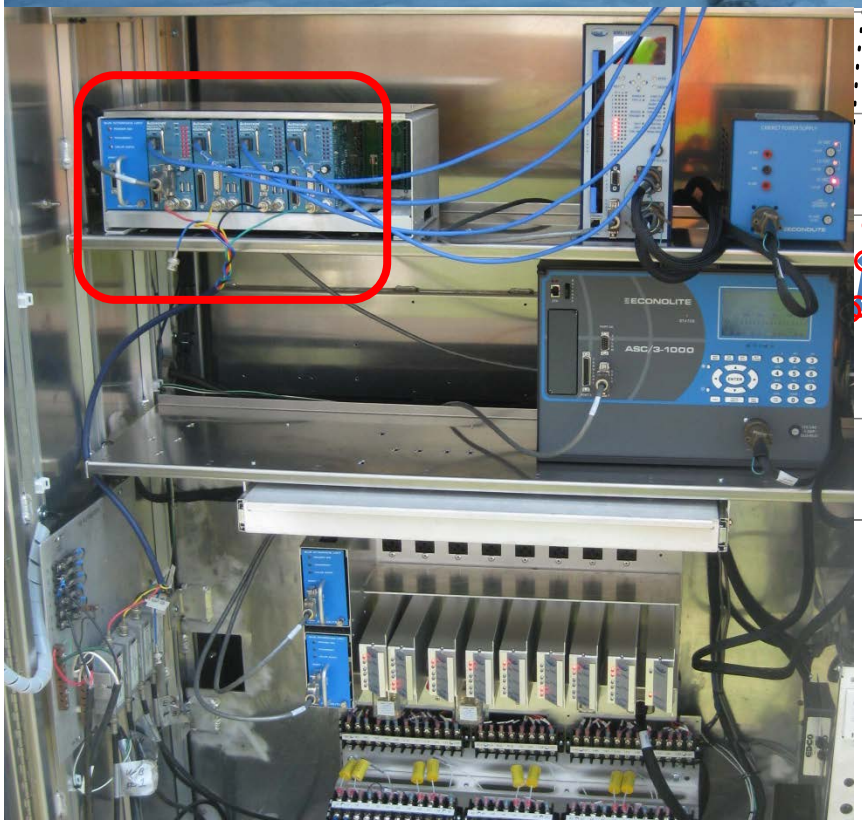
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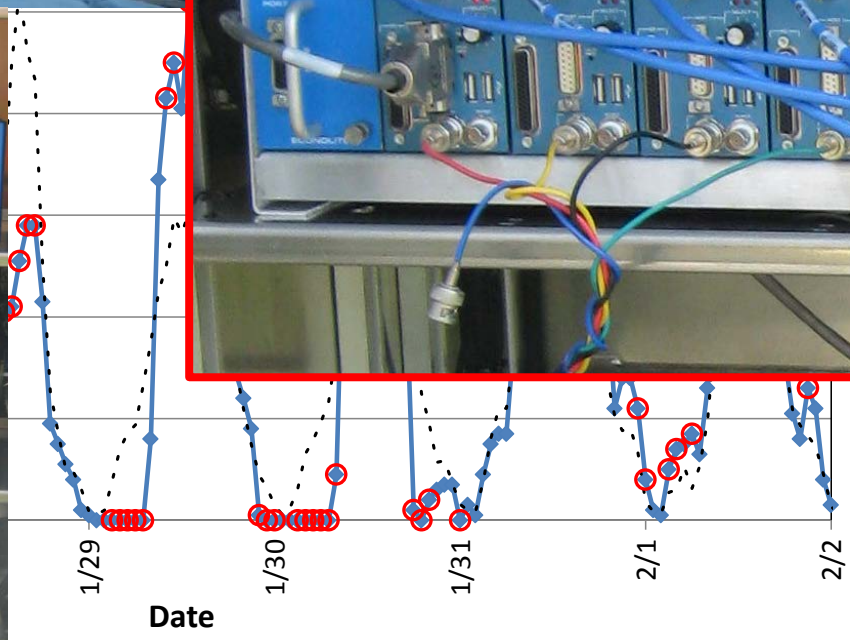
ASC/3-1000


1/29
1/30
1/31
2/1
2/2
Date

Case Study: March 12, 2014 Snow Event

Heavy, wet snow blowing from the North, covering lenses and signal indications

Time (EDT)	Temp.	Dew Poin	Visibility	Wind Dir	Wind Spe	Precip	Events	Conditions
12:53 AM	37.9 °F	35.1 °F	8.0 mi	NNE	10.4 mph	0.00 in	Rain	Light Rain
1:53 AM	37.9 °F	35.1 °F	10.0 mi	NNE	10.4 mph	0.01 in	Rain	Light Rain
2:53 AM	37.9 °F	35.1 °F	10.0 mi	NE	13.8 mph	0.00 in		Overcast
3:53 AM	36.0 °F	33.1 °F	10.0 mi	NE	20.7 mph	N/A		Overcast
4:53 AM	34.0 °F	32.0 °F	0.8 mi	North	-	0.06 in	Snow	Light Snow
5:53 AM	33.1 °F	32.0 °F	0.2 mi	North	-	0.08 in	Fog , Snow	Heavy Snow
6:53 AM	32.0 °F	28.9 °F	0.5 mi	North	-	0.03 in	Fog	Fog
7:53 AM	30.9 °F	28.0 °F	0.5 mi	North	-	0.02 in	Fog , Snow	Snow
8:53 AM	28.9 °F	27.0 °F	0.5 mi	North	-	0.01 in	Fog , Snow	Snow
9:53 AM	28.9 °F	26.1 °F	0.8 mi	North	-	0.00 in	Snow	Light Snow
10:53 AM	28.9 °F	26.1 °F	0.8 mi	North	-	0.00 in		Overcast
		°F	1.2 mi	North	-	N/A		Overcast
		°F	4.0 mi	North	-	N/A		Haze
		°F	10.0 mi	North	-	0.00 in	Snow	Light Snow
		°F	10.0 mi	North	-	0.00 in		Clear
		°F	10.0 mi	North	-	N/A		Mostly Cloudy
		°F	9.0 mi	North	-	N/A		Overcast
		°F	10.0 mi	North	-	N/A		Overcast
		°F	10.0 mi	North	-	N/A		Partly Cloudy
		°F	10.0 mi	North	-	N/A		Clear
		°F	10.0 mi	North	-	N/A		Clear
		°F	10.0 mi	North	-	N/A		Clear
		F	10.0 mi	North	-	N/A		Clear
		F	10.0 mi	North	-	N/A		Clear

Photo: Elkhart Truth

Case Study: March 12, 2014 Snow Event

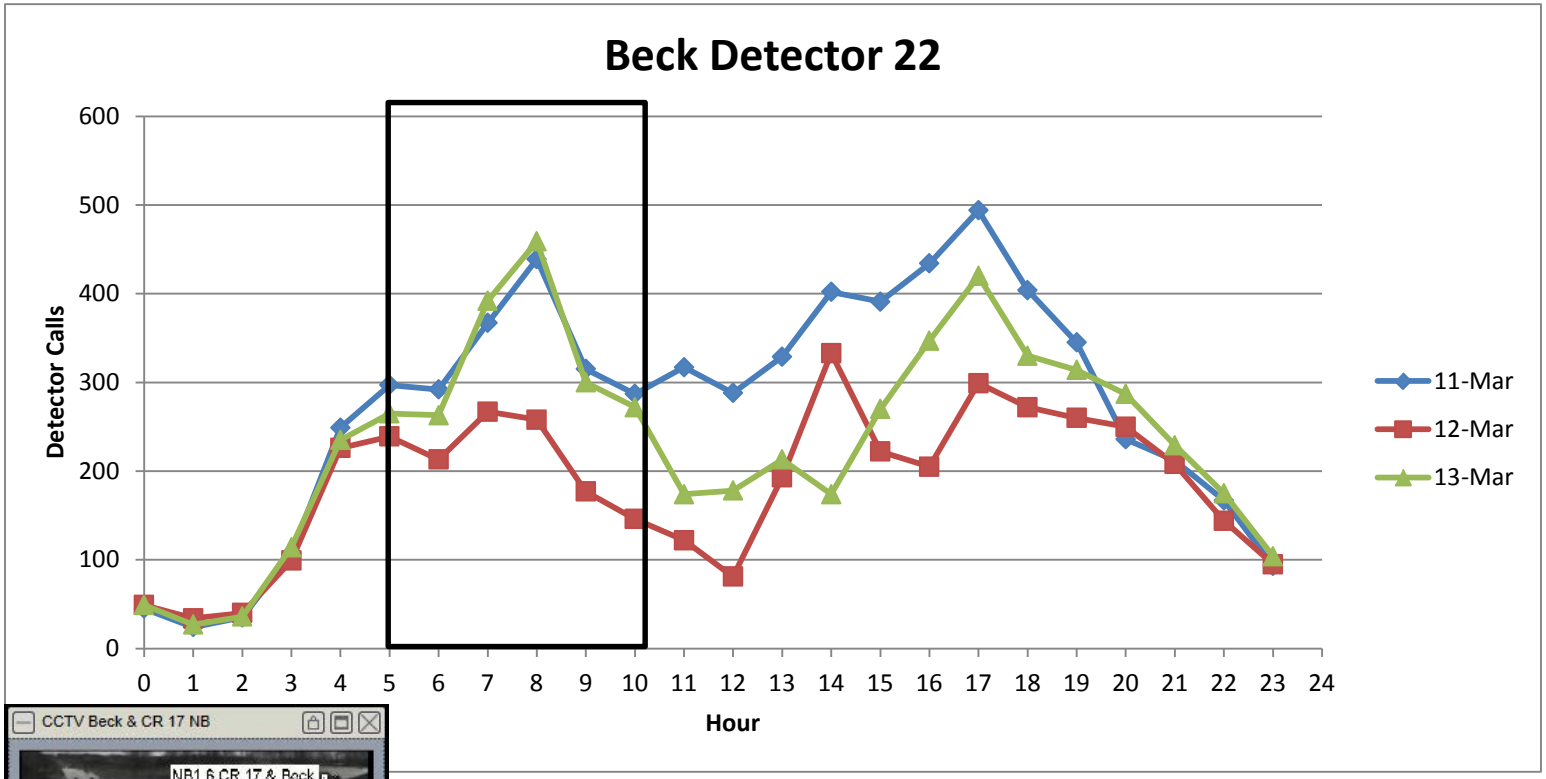
Beck Intersection Video Detection

SB Detector 18

NB Detector 22

Case Study: March 12, 2014 Snow Event

Beck Intersection Video Detection

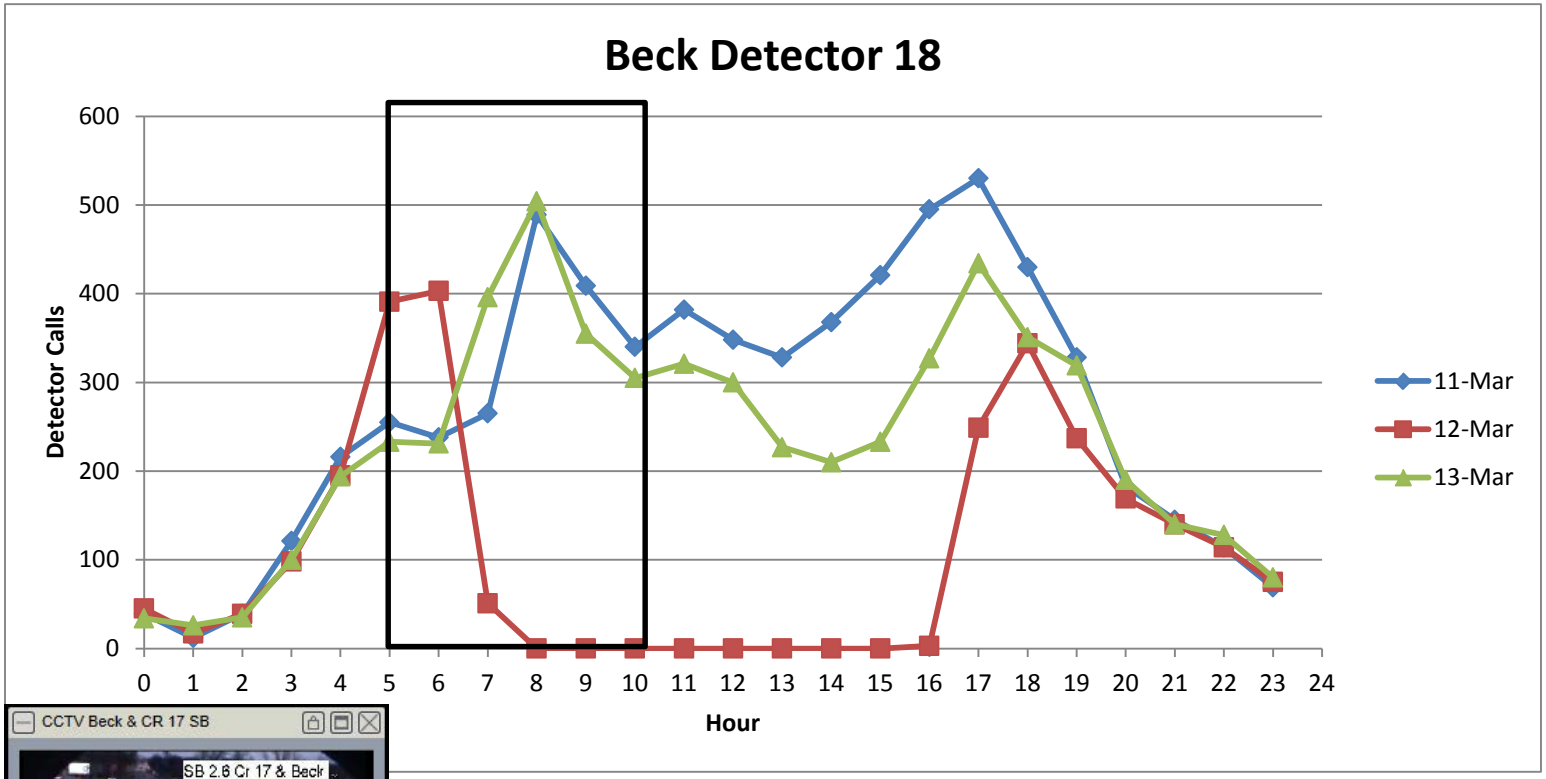


Facing South

NB Detector 22

Case Study: March 12, 2014 Snow Event

Beck Intersection Video Detection

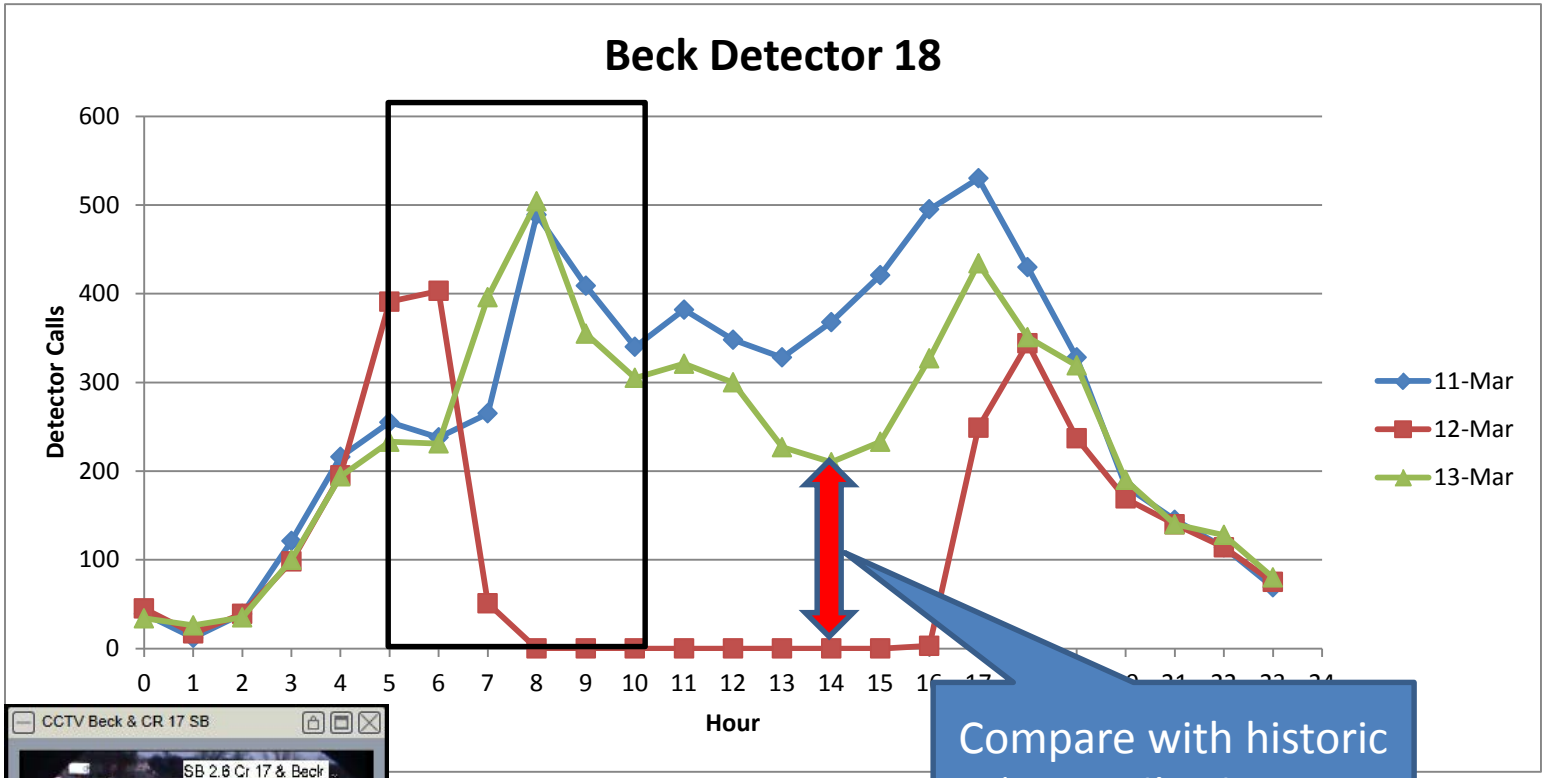


Facing North

SB Detector 18

Case Study: March 12, 2014 Snow Event

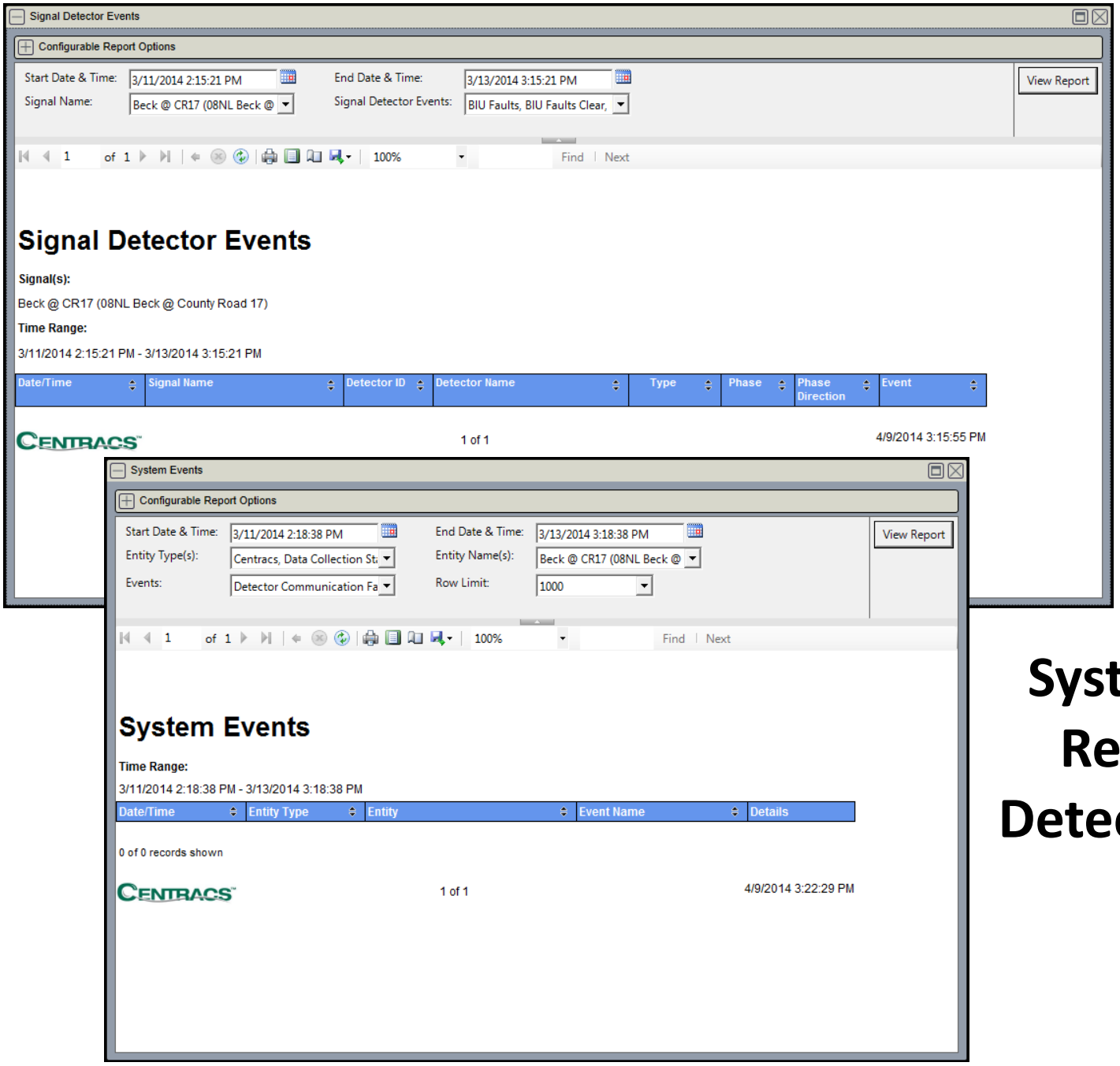
Beck Intersection Video Detection



SB Detector 18

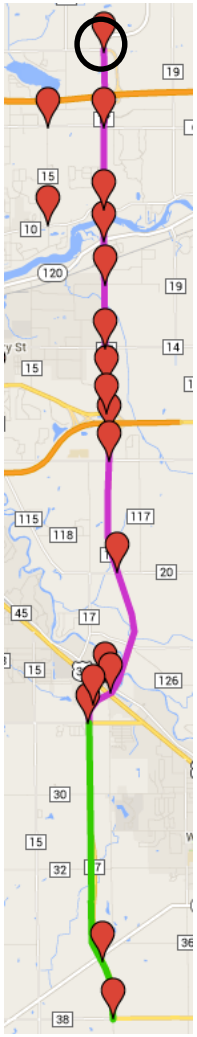
Facing North

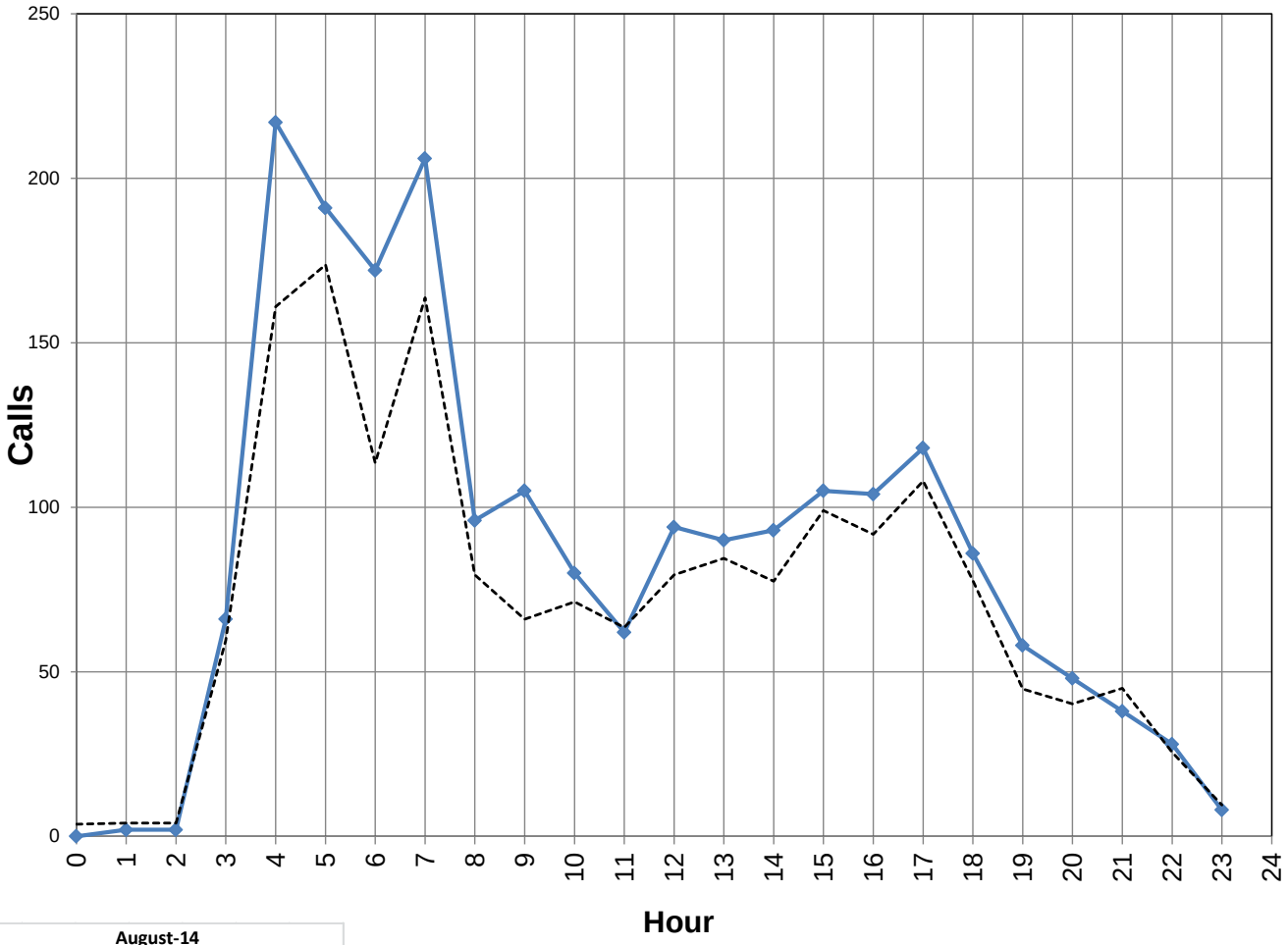
Compare with historic 'Normal' values to trigger system alerts



System Didn't Report Any Detection Errors

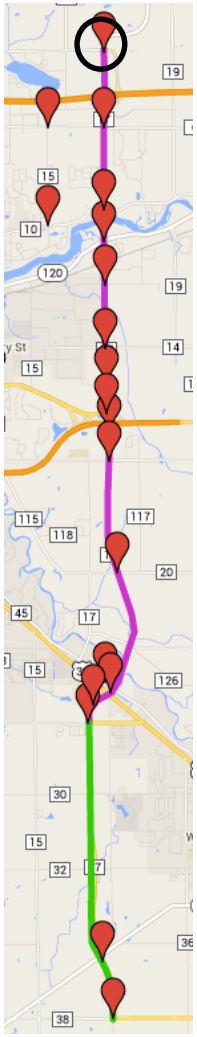
Case Study: CR 4 Loop failure

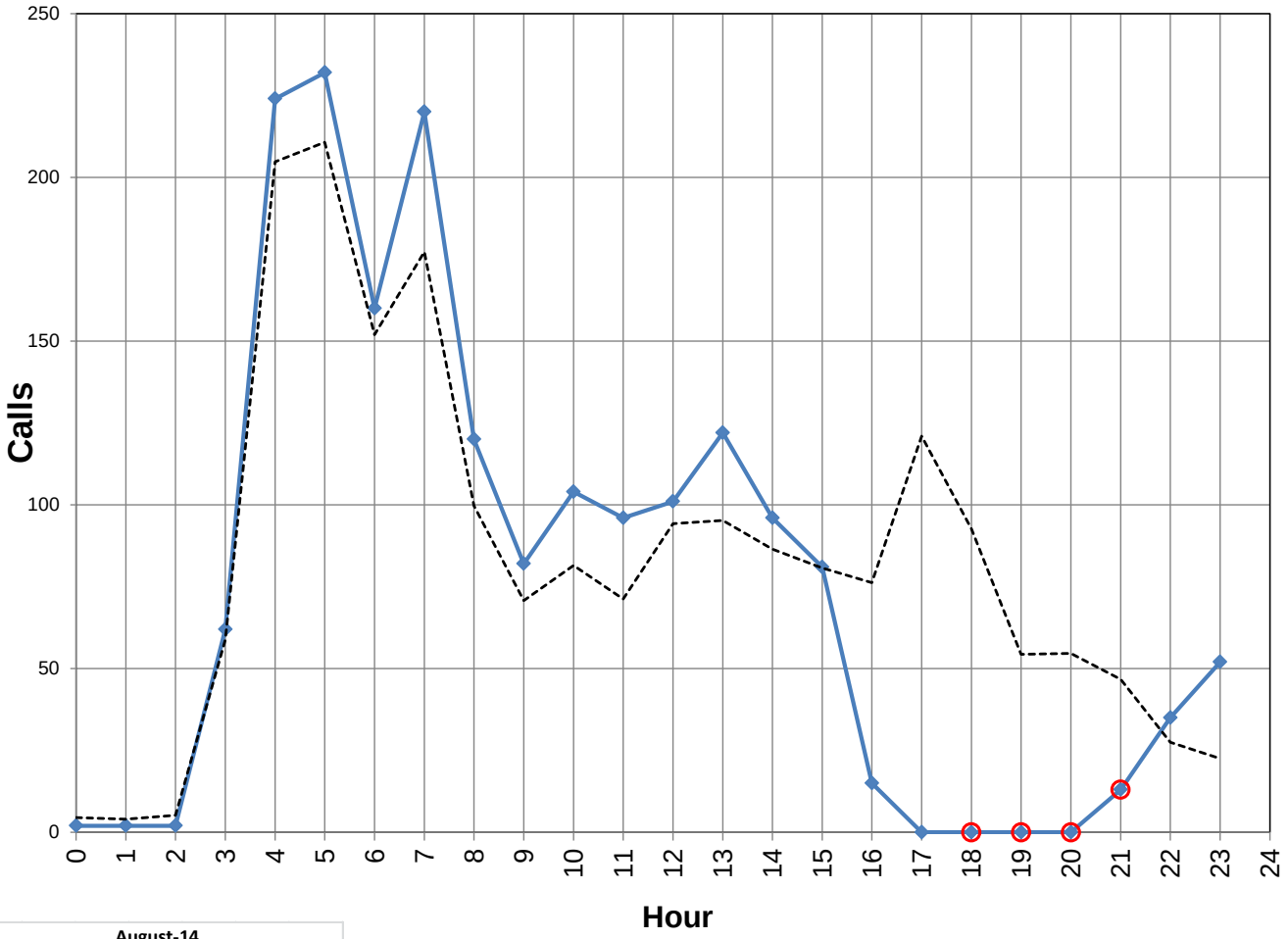




August-14						
S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

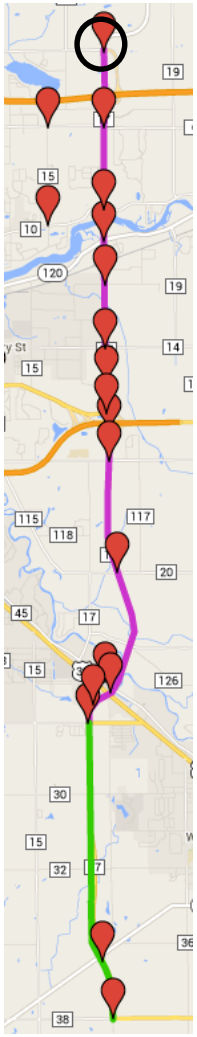
Case Study: CR 4 Loop failure

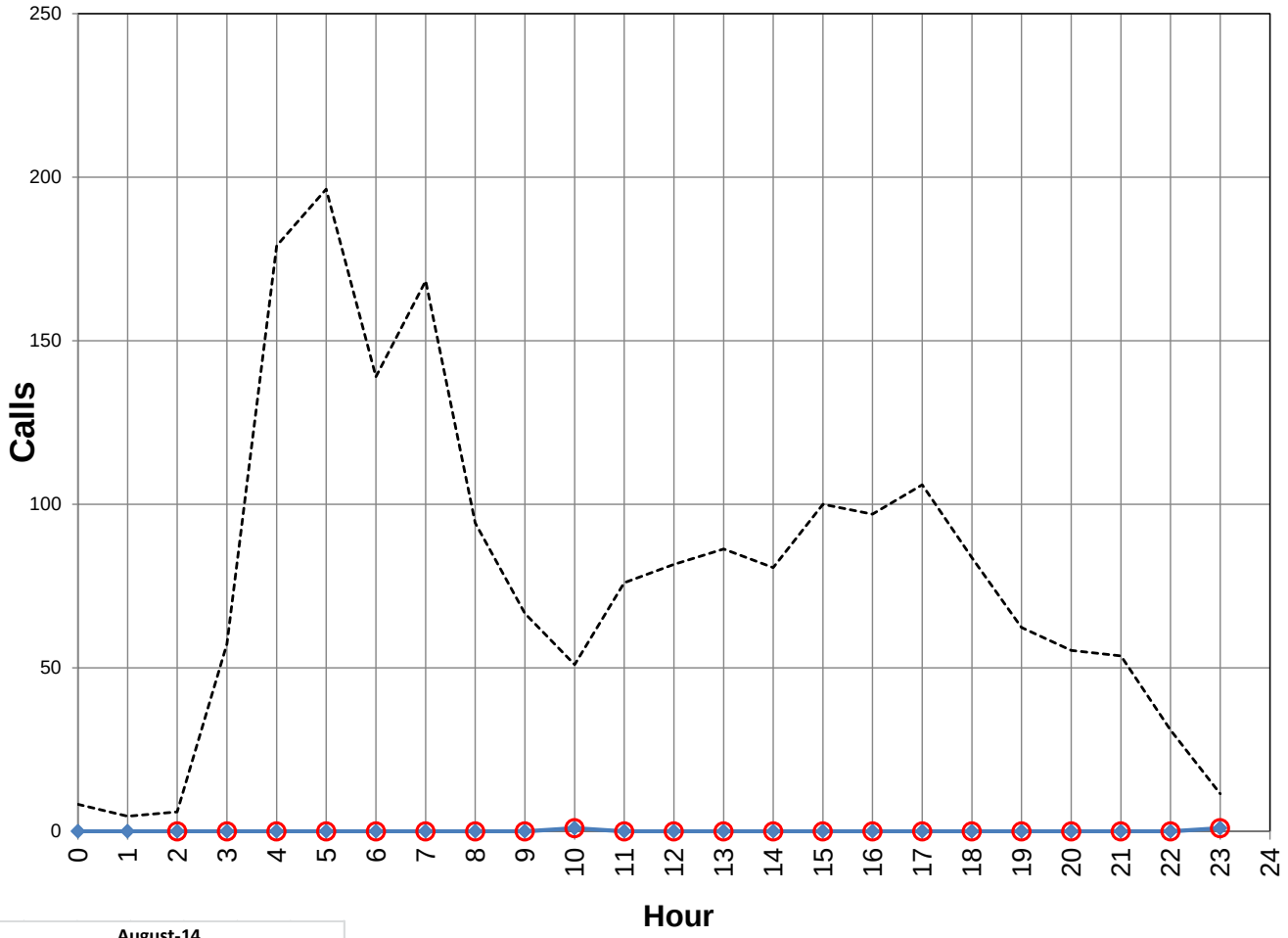




August-14						
S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

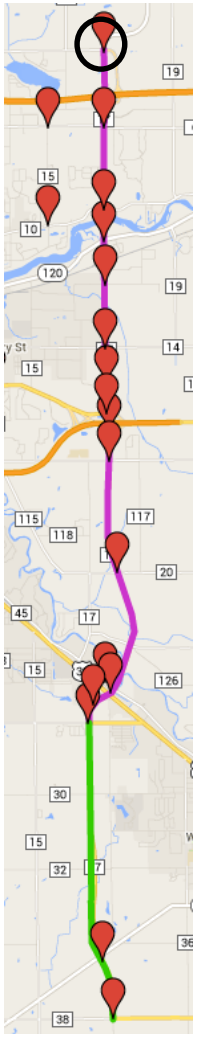
Case Study: CR 4 Loop failure

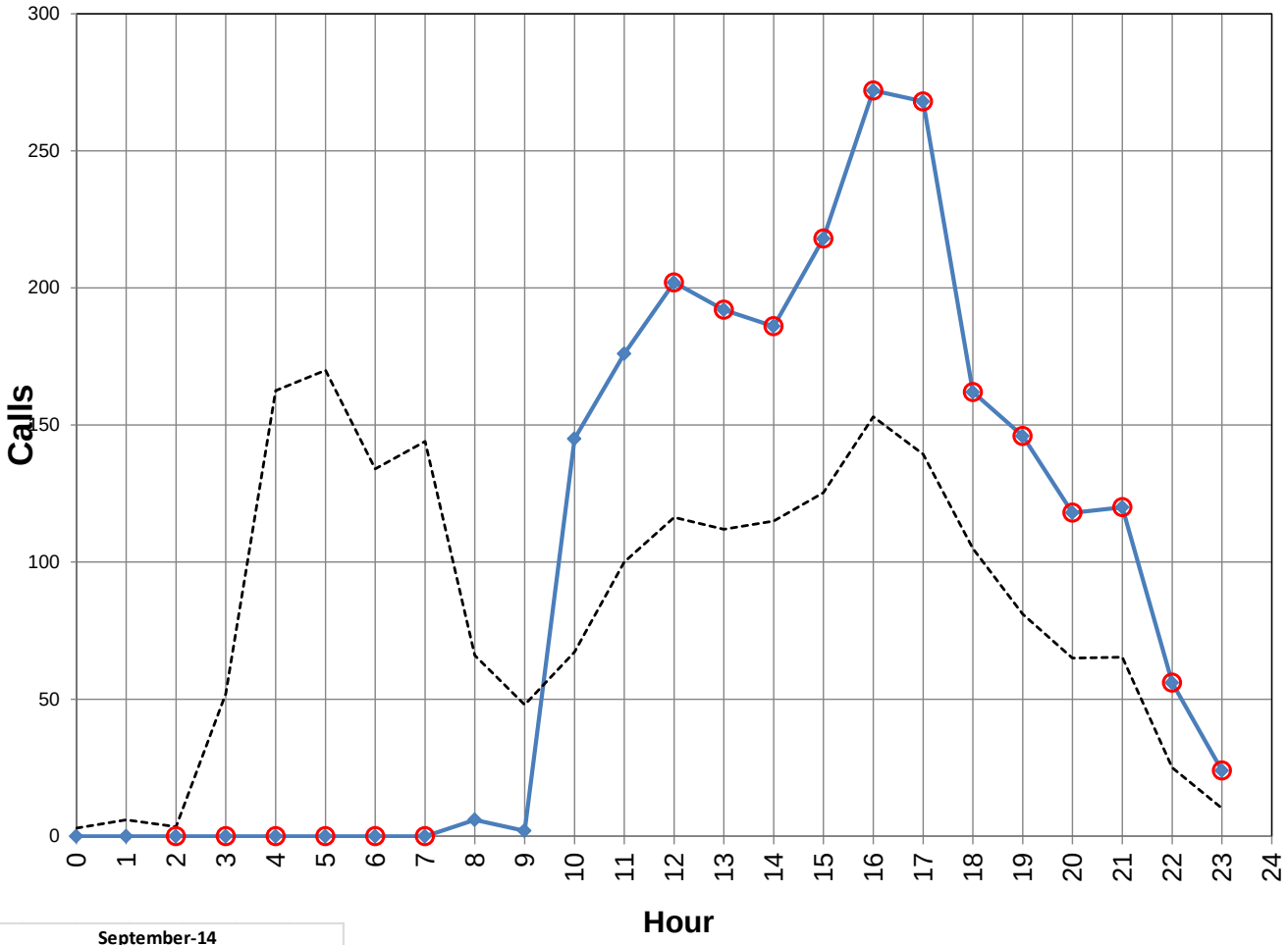




August-14						
S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

Case Study: CR 4 Loop failure





September-14						
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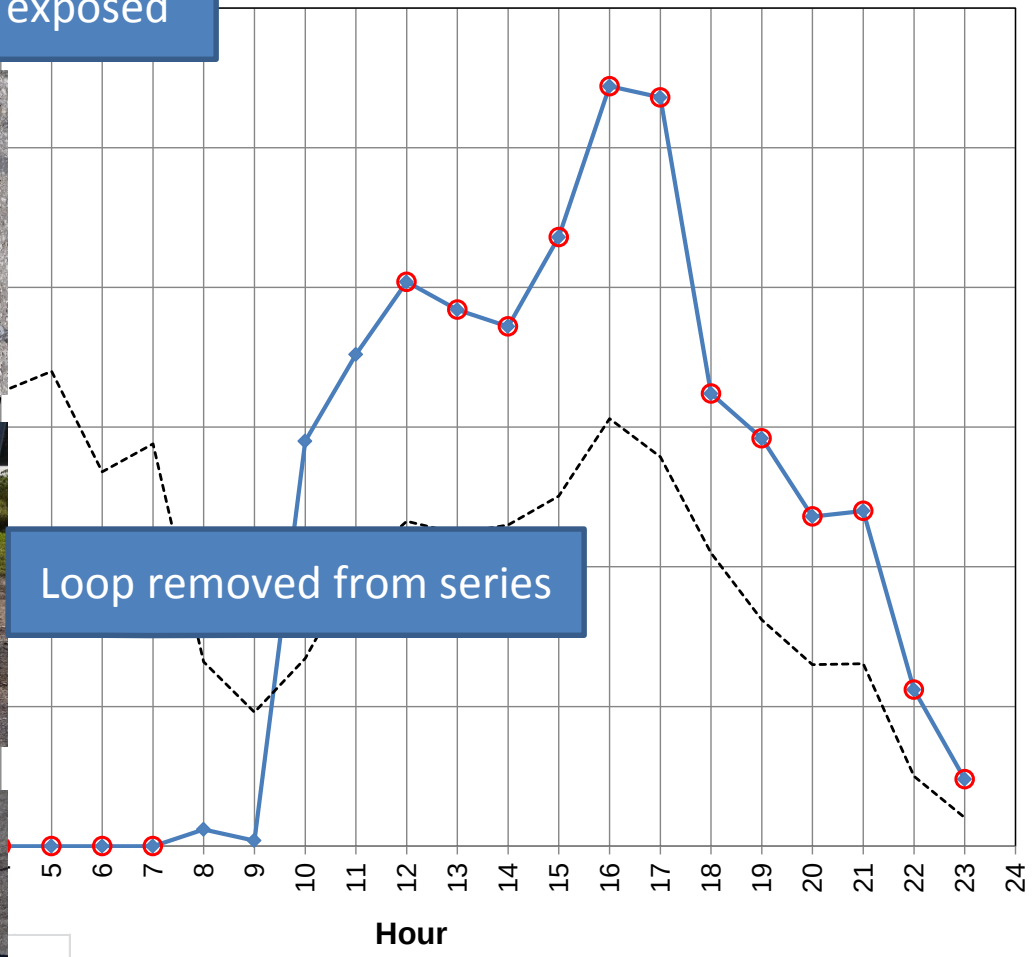
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

Case Study: CR 4 Loop failure

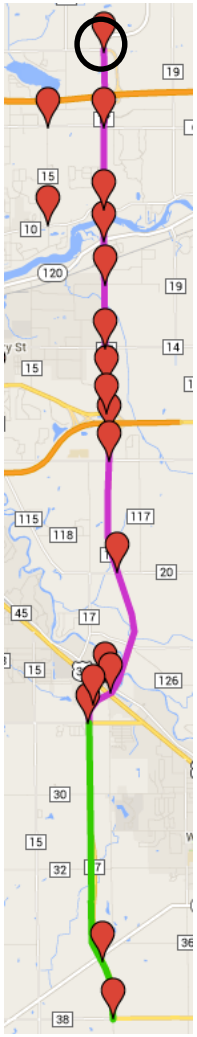
Pothole, lead-in exposed

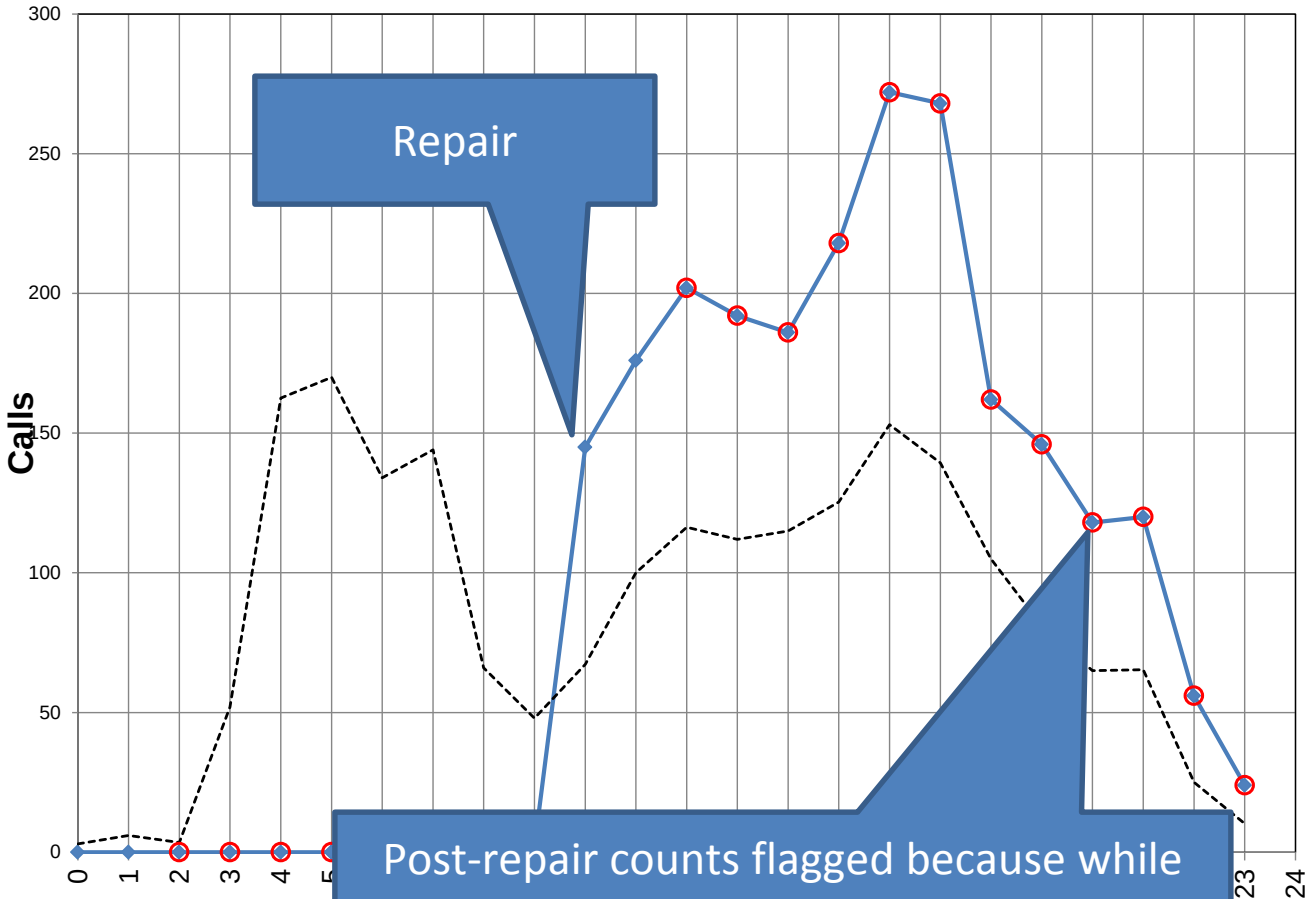
Loop removed from series

Labelled for repair



Case Study: CR 4 Loop failure

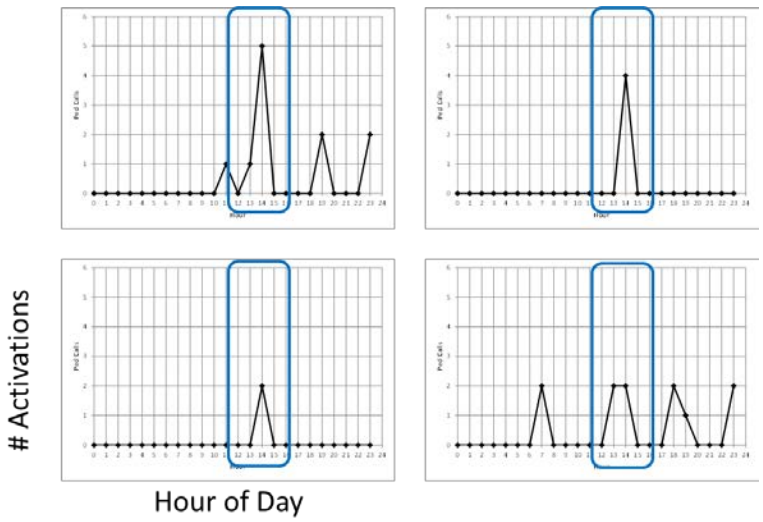




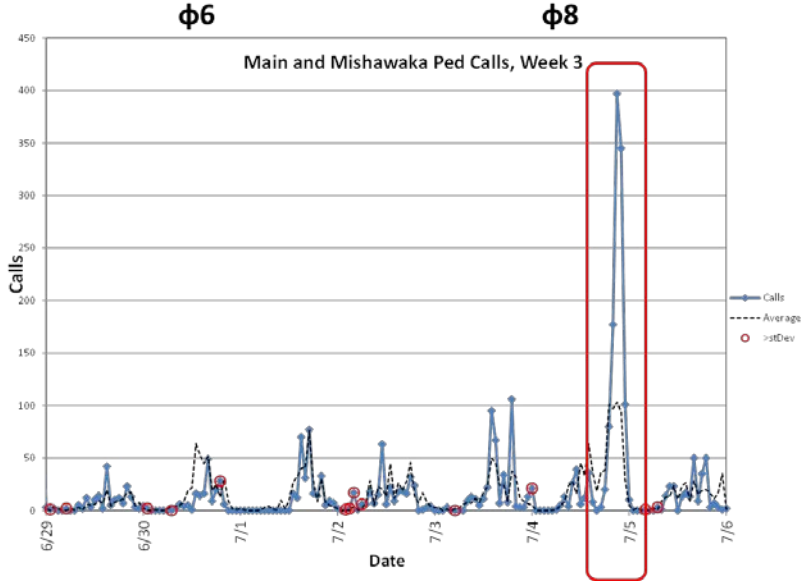
September-14						
S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

Conclusions

Maintenance performance measures



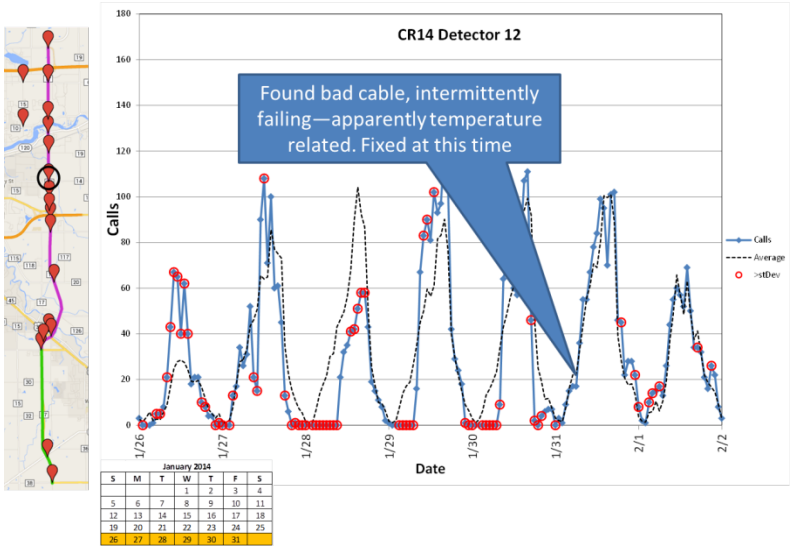
can be used to verify operation of call buttons



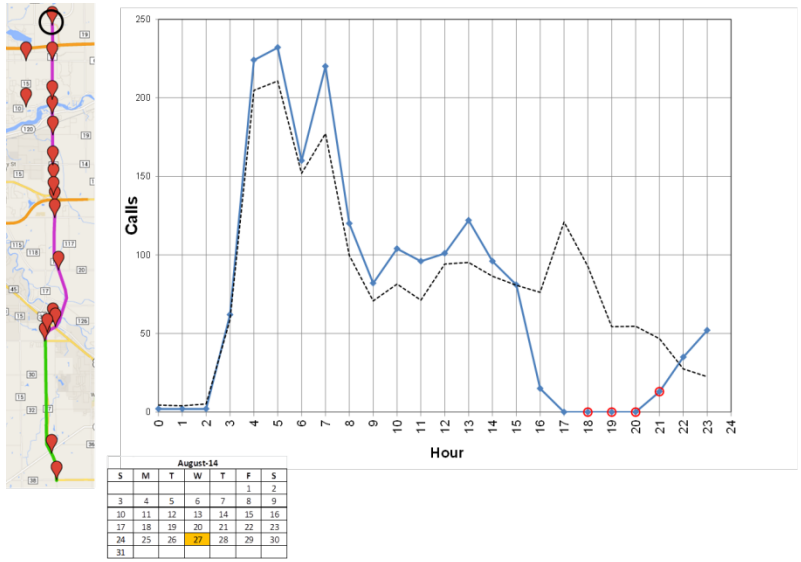
can be used to identify potential call button errors

Conclusions

Maintenance performance measures



can be used to identify intermittent errors that equipment failure reports may not



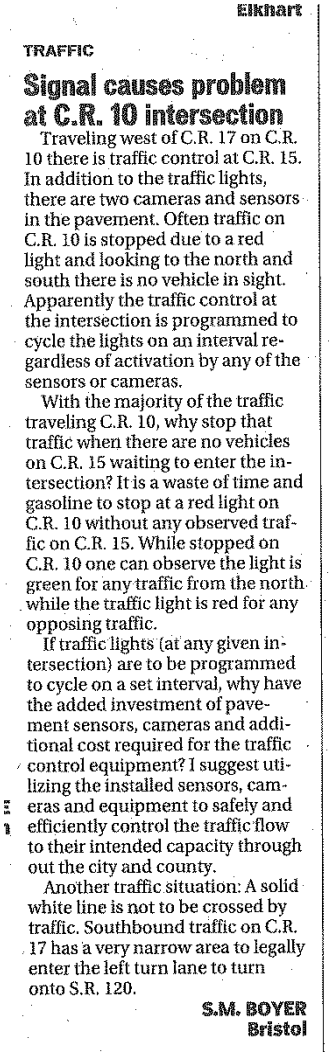
can be used to identify traditional failures

Three weeks of data for base line creation and a standard deviation of 1.5—2.0 worked well in study for error determination

Conclusions

Performance measures allow local agencies to more effectively manage signal systems with limited staffing

Find errors before this:



Elkhart

TRAFFIC

Signal causes problem at C.R. 10 intersection

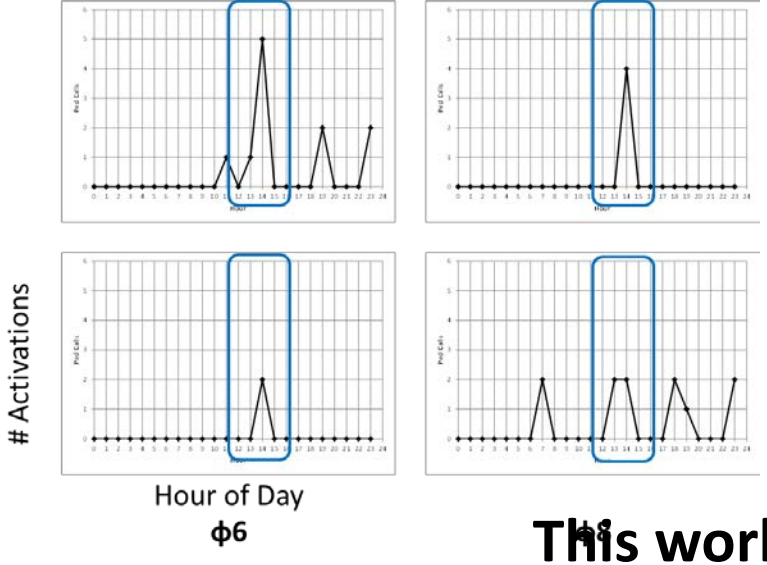
Traveling west of C.R. 17 on C.R. 10 there is traffic control at C.R. 15. In addition to the traffic lights, there are two cameras and sensors in the pavement. Often traffic on C.R. 10 is stopped due to a red light and looking to the north and south there is no vehicle in sight. Apparently the traffic control at the intersection is programmed to cycle the lights on an interval regardless of activation by any of the sensors or cameras.

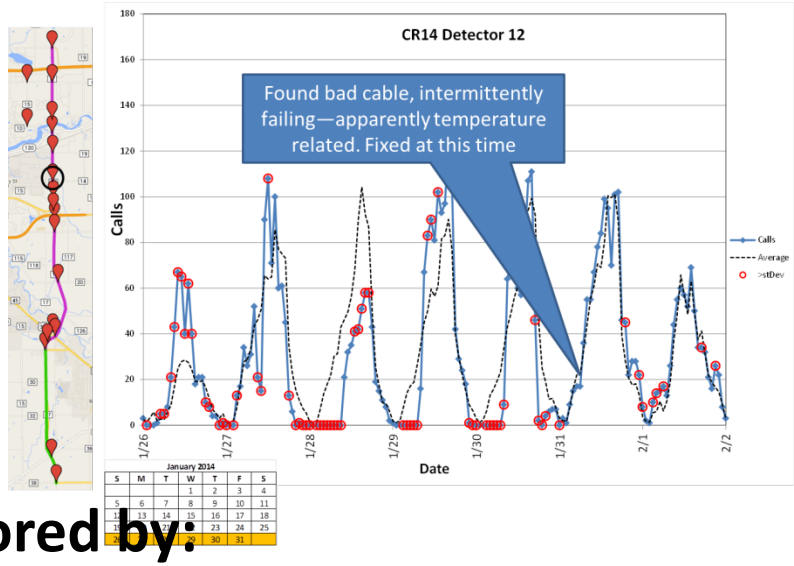
With the majority of the traffic traveling C.R. 10, why stop that traffic when there are no vehicles on C.R. 15 waiting to enter the intersection? It is a waste of time and gasoline to stop at a red light on C.R. 10 without any observed traffic on C.R. 15. While stopped on C.R. 10 one can observe the light is green for any traffic from the north while the traffic light is red for any opposing traffic.

If traffic lights (at any given intersection) are to be programmed to cycle on a set interval, why have the added investment of pavement sensors, cameras and additional cost required for the traffic control equipment? I suggest utilizing the installed sensors, cameras and equipment to safely and efficiently control the traffic flow to their intended capacity through out the city and county.

Another traffic situation: A solid white line is not to be crossed by traffic. Southbound traffic on C.R. 17 has a very narrow area to legally enter the left turn lane to turn onto S.R. 120.

S.M. BOYER
Bristol





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Indiana LTAP

and the

Joint Transportation Research Program at Purdue University